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Report
2000-05

# Live Fire Futures (LFF)

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**United States Army Research Institute**
**for the Behavioral and Social Sciences**

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**A Directorate of the U.S. Total Army Personnel Command**

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This study analyzes the impact of force modernization and asymmetric warfare on future live fire training, recommends a new live fire training strategy, and describes a concept for future live fire ranges. The U.S. Army's force modernization goals include improving the range, precision, and effects of direct and indirect fires. Such enhanced capabilities will significantly influence requirements for support of live fire training. Employment of smart weapons, non-line-of-sight weapons, new target acquisition systems, and digital command, control, and communications systems will characterize future combat and should be included in future training. The other major force for change in live fire training is the non-linear nature of future combat. Prominent in the U.S. Army's challenges of the 21st Century will be a wide range of possible operational environments in terms of strategic goals, the political-military situation, the nature of the enemy, civilian population considerations, and the characteristics of the battleground. These variables must also be addressed in the design of training support.

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Study Report 2000-05

# Live Fire Futures (LFF)

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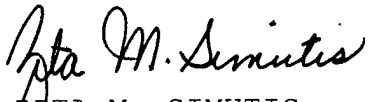
## FOREWORD

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Simulator Systems Research Unit (SSRU) conducts research and development and performs studies on training requirements for advanced training systems, devices and simulators. SSRU provides assistance to the U.S. Army Simulation, Training and Instrumentation Command (STRICOM), and the U.S. Army Training and Doctrine Command (TRADOC) in test and evaluation activities, training requirements definition, development of device specifications, and evaluation of training equipment concepts. An important area addressed by the unit is the development of automated systems to support exercise control and feedback for collective training exercises.

The current study was conducted in response to a request from the U.S. Army Training Support Center (ATSC) Army Training Modernization Directorate (ATMD) to examine the need for refining the Army's live fire training strategy and live fire ranges. Performing this work required: defining the U.S. Army's current live fire training strategy; identifying the benefits of live fire versus live force-on-force training; identifying existing problems in the execution of live fire training; assessing the impacts of force modernization and non-linear battlefield tactics on the jobs of observer/controllers, analysts, and range planners; developing a new live fire training strategy; and designing a concept for future live fire ranges that maximizes benefits while reducing problems. This work was briefed to Mr. Terry Faber of ATMD on January 18, 2000.



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The authors wish to acknowledge the important ideas and insights about training contributed by those interviewed. Personnel from the Joint Readiness Training Center (JRTC) at Ft. Polk, LA, the National Training Center (NTC) at Ft. Irwin, CA, and the Combined Arms Center at Ft. Leavenworth, KS provided valuable information regarding present and future training requirements.

LIVE FIRE FUTURES (LFF)

## EXECUTIVE SUMMARY

Requirement:

The U.S. Army has launched a major initiative to transform itself in response to emerging information age technologies, dramatically altered political and socioeconomic factors, and new mission requirements. The transformation includes force modernization and sweeping change to organizational and operational concepts. Illustrative of the new operational concepts is the expectation that non-linear battlefield dynamics will replace more conventional battlespace geometry as automated situational awareness and digital command and control systems come to dominate military operations. The U.S. Army Training Support Center Army Modernization Training Directorate (ATMD) asked ARI to estimate the impacts of force modernization and non-linear battlefield tactics on live fire training and develop a new live fire training strategy, if necessary.

Procedure:

We reviewed the literature to define the expected impacts of force modernization and non-linear battlefield tactics on Army training, focusing on live fire training. We reviewed the literature and interviewed Army leaders at the National Training Center (NTC), the Joint Readiness Training Center (JRTC), and the Combined Arms Center to:

- define the evolution of Army live fire training;
- define the Army's current live fire training strategy;
- identify the relative benefits of live fire versus live force-on-force training;
- decide how exercise control and feedback functions of trainers and analysts differ between live fire and live force-on-force training;
- decide how collective training objectives differ between live fire and live force-on-force training;
- identify the expected impacts of force modernization and non-linear battlefield tactics on the jobs of trainers and analysts and on training resource requirements;

- assess the need for developing a new training strategy and range concepts.

Findings:

We concluded that live fire training is superior to live force-on-force training in terms of engendering confidence in self and buddies, instilling leaders and soldiers with confidence in weapons and equipment, and engendering safe operations. The jobs of trainers and analysts are very similar across live fire and live force-on-force training except that safety is a more demanding exercise control function with live fire. At present there is not a detailed strategy for live fire training. We proposed such a strategy, and the most controversial aspect of this strategy is requiring virtually all unit types to participate in local defense live fire exercises. The need for such exercises comes from the increased probability that units not normally involved in direct fire engagements with the enemy can be involved in such engagements on the asynchronous battlefield. Attempting to create live fire ranges that reflect the situations faced on the asynchronous battlefield greatly exacerbates safety problems, but failing to employ an asynchronous setting reduces training realism. We proposed a concept for a future live training range that can reduce safety risks without sacrificing realism.

Utilization of Findings:

The results of this study will be used as input for the Advanced Ground Targetry Advanced Concepts and Technology II (ACT II) effort requested by ATMD for execution by an Army Battle Lab. This study was used by ATMD to help justify the need for the ACT II project.

LIVE FIRE FUTURES (LFF)

Contents

Contents (Continued)

Page



## List Of Tables

Page

## List of Figures

# LIVE FIRE FUTURES (LFF)

## Introduction

U.S. Army active and reserve forces face a challenging future due to dynamic changes in the international political situation, variability in the nature of conflict, constrained resources, new missions, and new technology. These factors require innovative thinking and new ways of training for the U.S. Army to be ready to respond to future requirements with a force capable of accomplishing a variety of missions across a demanding range of scenarios. The Live Fire Futures Study proposes an Army-wide strategy for live fire training and provides a concept for the design of live fire training ranges which exploits new and emerging technology in order to support the transition of today's Army into the modernized force.

## Purpose

This study was conducted to assess the impacts of force modernization and new doctrine on live fire training, develop recommendations for a new live fire training strategy, and provide a concept for the design of live fire ranges which support collective training in the future.

## Study Objectives

Study objectives were as follows:

- Define the current live fire training strategy.
- Describe differences between live fire and live force-on-force exercises in terms of collective training objectives, exercise control functions and feedback functions.
- Describe the effects of force modernization and non-linear tactics on training strategies, collective training objectives, trainer and analyst workloads, and resource requirements for live fire exercises.
- Develop an Army-wide live fire training strategy.
- Develop a design concept for a future live fire range.

## Background

The U.S. Army Training Support Center (ATSC) Army Training Modernization Directorate (ATMD) is responsible for defining training support requirements for live exercises at home stations and at the Army's maneuver combat training centers (CTCs). ATMD envisioned a multi-year program for investigating the effects of force modernization on the live training environment (Faber, 1996). ATMD's plan calls for behavioral studies to describe the influence of force modernization on trainers and analysts and to provide input to the design of future live training support systems. ATMD recognizes that modernization may change the way that tactical units use live, virtual, and constructive training facilities.

ATMD requested that the U.S. Army Research Institute (ARI) conduct a series of studies concerned with describing how force modernization will influence the duties of observer/controllers (O/Cs) and analysts for live force-on-force and live fire exercises. Earlier studies in this series concluded that workloads of O/Cs and analysts will increase significantly for force-on-force exercises as O/Cs and analysts support the simulation of new weapons and collect data on the use of new digital systems (Brown, Nordyke, Gerlock, Begley II, and Meliza, 1998; Brown, Anderson, Begley II, and Meliza, 1999b).

## Study Approach

It was critical for us, as we initiated our work, to understand the unique benefits offered by live fire training so that our recommendations for future training strategies and range concepts would capitalize on these benefits. Similarly, it was critical that we understand existing and future problems executing live fire training so that our recommendations would help to address these problems.

Through literature reviews and interviews with Army leaders, trainers, analysts, and range planners we attempted to answer the questions below.

- How has live fire training evolved?
- What are the relative benefits of live fire versus live force-on-force training?
- How do live fire and live force-on-force training differ in terms of the tasks performed by O/Cs and analysts?

- What level of guidance does doctrine provide regarding live fire training strategies?

- How do force modernization and asymmetric battlefield tactics influence the jobs of O/Cs, analysts, and range planners?

- How do force modernization and asymmetric battlefield tactics influence training objectives and resource requirements?

- What problems are encountered executing live fire training, and how are these problems influenced by force modernization and asymmetric battlefields?

- How can new training technologies influence the training benefits of live fire training and the problems associated with future live fire exercises.

First, we captured data from interviews and published sources. A broad assessment was used to define specific study requirements. Essential elements of analysis were developed to allow the study team to focus on critical aspects of asymmetric warfare and force modernization as they affect live fire training. We developed and used an interview guide and targeted critical personnel in order to gather data. We conducted face-to-face interviews to obtain data from JRTC and NTC O/Cs, training analysts, and range control personnel. Interviews were also conducted with senior personnel at the Combined Arms Center (CAC) at Ft. Leavenworth, Kansas. A literature search of Army publications relevant to live fire training was performed. (A listing of those interviewed and references are provided in the reference section.)

We then analyzed the data, developed conclusions about the nature of future live fire training requirements, and formed recommendations of how to meet those requirements with a notional range design that exploits technology to meet future requirements. An Army-wide strategy for conduct of live fire training was developed for consideration by Army leadership. The results of the study were then documented with this final report (see Figure 1).

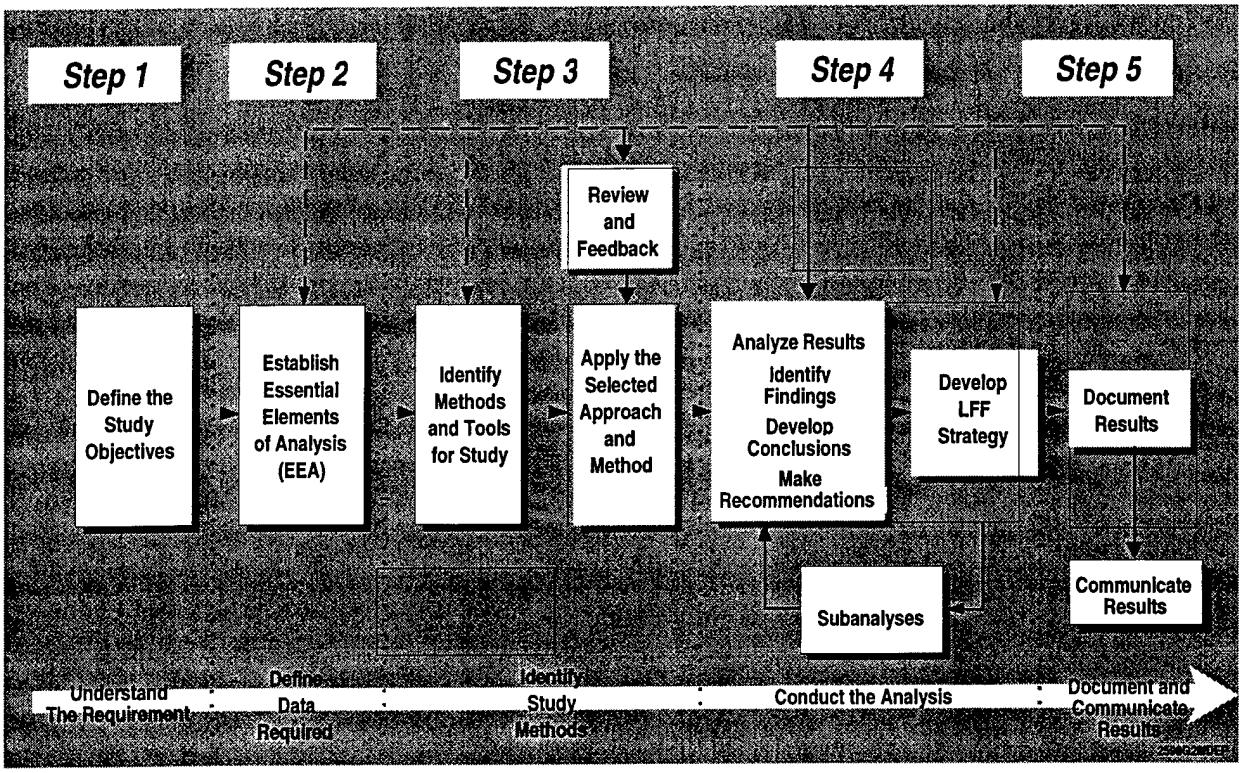



Figure 1. Live fire futures study approach.

## History and Status of Live Fire Training

### Origins of Current Live Fire Training

The CAC History (1993) provides a description of the model for present day live fire exercises that emerged at Ft. Hood, Texas. In 1974 the U.S. Training and Doctrine Command (TRADOC) began to develop a concept for a training center where tank and mechanized forces could conduct force-on-force maneuvers and live fire exercises. Active Defense doctrine drove trainers to address force modernization and to develop training programs and training support to accommodate the new doctrine and new weapon systems.

The TRADOC Combined Arms Test Activity developed a concept for a range that met the requirements and did so realistically. The solution was two-fold; force-on-force exercises using Multiple Integrated Laser Engagement System (MILES) equipment for "real-time" casualty assessment, and live fire exercises using remotely controlled targets.

The live fire range tested at Ft. Hood differed significantly from other ranges of the time. Using commercially available target mechanisms, a defensive range and scenario were designed to portray a Soviet reinforced motorized rifle battalion in the attack. The training objective was one of a defense using a defense in sector scenario. The training audience was a defending company team consisting of tanks, TOWS, an infantry platoon (minus Dragons and light antitank weapons), and a fire support team. The enemy was portrayed by a total of 195 vehicular-type targets and 61 personnel-type targets arrayed in front of a battle position. The targets were distributed among seven belts ranging from 4,000 meters to 380 meters away from the battle position. Although the targets were stationary, they were raised and lowered in accordance with a time-sequence in order to create the illusion of an enemy force closing in on the friendly position at the rate of 12 kilometers per hour. Target exposure times were based on actual tank runs through the engagement area. The personnel targets were positioned at likely vehicle crew or infantry dismount points. All target and demolition devices were man-portable, remote-controlled, and battery-operated. Target gunfire simulators that fired white smoke on command and smoke devices that fired red smoke when a target was hit were connected to each vehicle target. The personnel targets were raised on command and were lowered automatically when hit. Demolitions were used to simulate the impact of friendly artillery.

Six live fire scenarios were developed. Test results indicated that such a live fire range was feasible and had excellent training value. The live fire exercise was well received by soldiers. Training insights were gained from detailed discussions with key personnel and during after-action reviews following each exercise. Commanders discussed the challenge of making many difficult tactical and logistical decisions for the first time under the pressure of a live fire environment. Leaders at all levels related experiencing stress during the training as they faced a massed enemy advancing at real time speeds under the cover of artillery and smoke. The test demonstrated aspects of simulated combat that previous training events had been unable to portray.

Army leaders recognized that the range of modern weapons, increased mobility of the soldier, and combined arms realities of modern war required more space to exercise and replicate the increased tempo and greater lethality of the battlefield. However, no existing home station facility could support such maneuver exercises at the battalion or brigade levels with the resources required to portray a realistic opposing force, provide O/Cs, and furnish the instrumentation to document the results of the training exercises. With such requirements in mind, TRADOC established the NTC, located at Fort Irwin, CA. The first rotation of forces trained at the NTC in 1981.

Building on the success of the NTC, in 1986 TRADOC began to develop a facility for training light forces. Initially located at Fort Chaffee, Arkansas, the JRTC eventually moved to Fort Polk, Louisiana. The NTC, the JRTC, and the upgraded training center at Hohenfels, Germany, renamed the Combat Maneuver Training Center (CMTC), constitute the Army's current set of combined arms live fire and force-on-force training facilities. In January 1987, the Chief of Staff of the Army approved a master plan bringing the NTC, JRTC, CMTC, and Battle Command Training Program together under a unified program.

## The Army's Present Live Fire Training Strategy

The Army has no unified and authoritative expression of a strategy for live fire training, despite a general consensus about the necessity for such training. There is no prescription of tasks, training audiences, and frequency of training for the entire force.

Although our literature review found elements appropriate to a training strategy, we found no documentation that presented all components in the context of one strategy or concept. Field Manual (FM) 25-100, Training The Force, contains no direct discussion of live fire or force-on-force training requirements, although it implies a live fire training requirement. FM 25-101, Battle Focused Training, recognizes the importance of live fire training and portrays live fire exercises very high on an "inference curve," (Figure 2) framed by realism and level of resourcing. The Army's Standards in Weapons Training (STRAC) manual is the resource document for live fire training. Its focus is allocation of ammunition. While it addresses some types of units' training tasks and frequency, it does not address others.

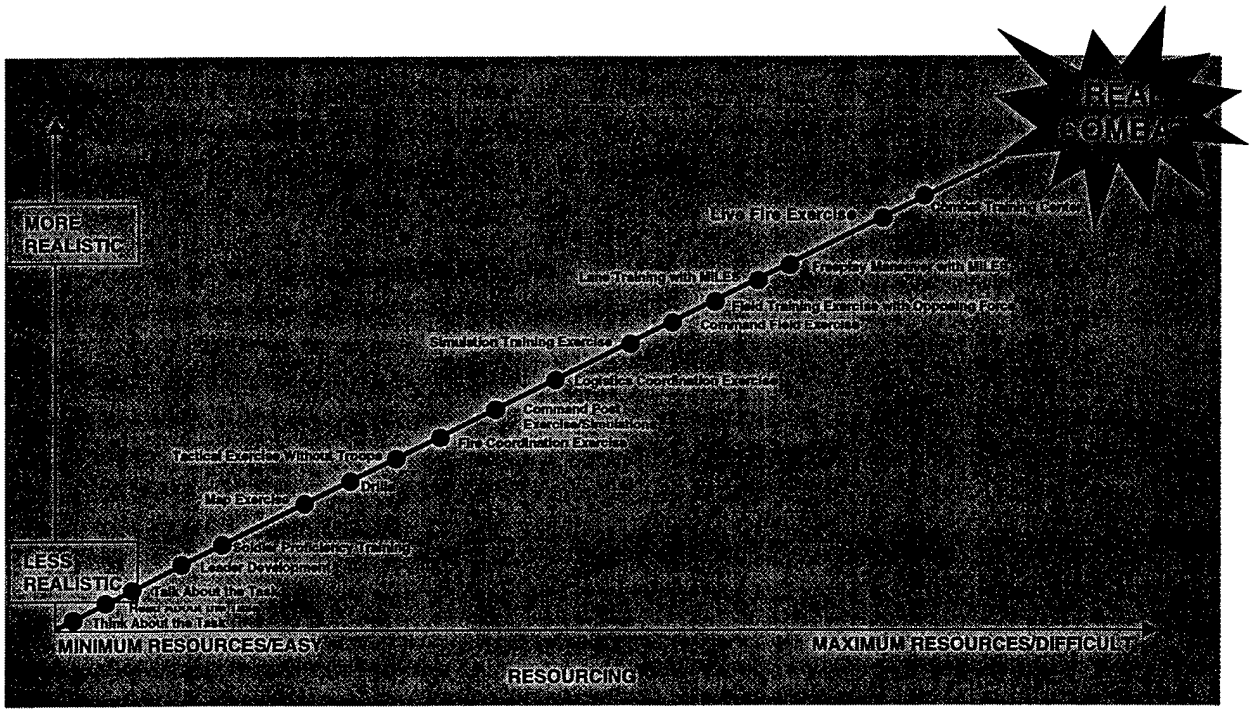



Figure 2. Spectrum of training approaches (FM25-101, 1990).

Major Command training documents identify broad requirements for live fire exercises and provide some detailed guidance as to tasks and frequency. An example is provided by the final draft of the United States Army Europe (USAREUR) Training Regulation, Training in USAREUR/7A (1999).

> "Warfighter readiness is the highest priority. For soldiers to remain combat ready, commanders must emphasize basic warfighting skills essential to battlefield success. ... Whether with a rifle,

machine gun, tank, Bradley fighting vehicle, or howitzer, hitting what you aim at -- a defining factor of lethality -- is a basic skill in the profession of arms. ... Abrams and Bradley-equipped units will conduct record qualification gunnery only at GTA (Grafenwoehr Training Area). Commanders will also take advantage of GTA's potential for section, platoon and company level maneuver training. As previously stated, the ability to train to standard in the live domain at home station is one of the biggest challenges in USAREUR. ... Combined arms live-fire exercises (CALFEXs) complement maneuver exercises at a combat training center. The recommended components of this strategy include gunnery, maneuver, and command and control (C2) training. Maneuver units will conduct CALFEX training in accordance with DA PAM 350-38 to ensure combat proficiency is maintained. CS and CSS units will conduct periodic rear-area live-fire exercises to ensure the unit is proficient at perimeter defense and Quick Reaction Force (QRF) tasks. ... A certification gate is a standard objective. ... The following certification gates apply to USAREUR units. (1) Tank and Bradley platoons will successfully execute a platoon gunnery trainer (PGT) simulation before executing Table XII. (2) Tank and Bradley platoons will qualify on Table XII not earlier than six months prior to executing company-level Live Fire. (3) Prior to conducting a CALFEX, company and higher units will successfully complete a Fire Coordination Exercise (FCX). (4) Tank and Bradley company teams will successfully complete a full caliber, live fire CALFEX prior to conducting a battalion task force level full caliber, live fire exercise. ... The CMTC Live Fire at GTA currently focuses on company team live fire operations. At end state, the CMTC Live Fire will provide units the capability to conduct task force live fire operations after executing the company team level live fire as a gate. The program provides a flexible (up to five days of 24 hour operations) tactical combined arms scenario incorporating defensive and offensive missions to allow a combined arms task force (-), controlled by a battalion task force headquarters, to conduct live fire and maneuver at GTA. ... The goal is trained units able to plan, coordinate, synchronize, and execute combined-arms, multi-echelon, live fire events. Soldiers and units will develop confidence in

their ability to safely execute tactical combined arms live fire operations through this exercise."

Present live fire training for individuals and crews consists primarily of proponent branch-prescribed tables for particular weapons, weapons systems, and type units. All tables emphasize safety, accuracy, and speed. Armor provides a good example. Tank crew and tank unit tables build from rudimentary skills of crewmen in tank tables (TT) I, II and III through crew proficiency in TT IV through VIII to unit training TT IX through XII (Combined Live Fire Exercise).

## Variables Important to Live Fire Training Strategies

Live fire training of collective tasks is usually constrained by range limits that allow the unit to focus all of its attention in a well-defined "down-range" area. Artificially narrow range fans, two-dimensional targets, and fully exposed movement of moving targets limit realism, movement, and maneuver. Target sets normally don't simulate enemy maneuver or return fire. Standard drills, movement techniques and tactical formations have to be adapted to range limitations. There is a clear beginning and end to live fire training—one is never called on to use weapons unexpectedly in the midst of other activities. Safety considerations impose interruptions and constraints that interfere with the realism of the training. Also, the general lack of battlefield activity (e.g., adjacent systems/units' signatures, normal tactical radio traffic, civilian vehicles and people), obscurants, and jamming constitute shortfalls in the realism of current live fire training.

Personnel turbulence plays a key role in the readiness of units. Personnel turbulence has an especially important impact on determining the frequency at which units should conduct live fire training. Individual weapons qualification firing must occur often enough so that the aggregate of individual skills does not fall below an acceptable level. The impact on unit proficiency is greater than the sum of individual proficiencies because every soldier is part of a team. Each team is part of a team of teams. A reduction in capability at a lower echelon can affect the capability of the larger unit. A change in the team's personnel reduces team proficiency and adversely impacts on intangible aspects of unit confidence and teamwork that will be addressed later in this study. High rates of turbulence generate a requirement for added training.

Units attain proficiency with their weapons systems through cyclical programs. Individual weapons proficiency is based on a progression from simulators through dry fire to semi-annual qualification with service ammunition. Crew training is similar. There are standards prescribed for individual and crew qualification. The situation is different for unit collective training, which incorporates live fire of all unit systems with all the other tasks for which the unit is responsible. The NTC provides an opportunity for combined arms live fire training for mechanized infantry and armor battalion task forces. The CMTC capability is much less, even when combined with Grafenwoehr. Echelons higher than company-team level, even at JRTC, rarely conduct dismounted live fire training.

## Comparisons of Live Fire and Live Force-on-Force Training

### The Value of Live Fire Training (Validating the Need)

All those interviewed for this study acknowledged the contributions to unit readiness of force-on-force training and were emphatic that live fire training was critical. Live fire training develops soldiers' and leaders' confidence in themselves, their teammates, their leaders, and their equipment. Tactical skills are reinforced. The Commander, JRTC Operations Group (COG) emphasized that the result of live fire training is intuitive in the soldier. This is an important point. Accomplishment of tasks in a live fire environment is a holistic learning process. More is learned than that which is identified by the standards, task steps, and performance measures reflected in the mission training plan (MTP). Important bits of skill and knowledge are acquired without being specifically addressed. Proof of this is beyond the scope of this study, but the authors' personal experience and the comments of those interviewed suggest that live fire training provides a learning experience that is unique in its intensity. The experience results in soldiers being better able to meet the demands of battle than if they were not so trained. The foregoing is supported by the results of the live fire tests at Ft. Hood, which demonstrated the value of tactically demanding and realistic firing exercises. Insights gained from this initial test included the value of challenging a commander's decision-making with the pressures of a live fire environment and a target array that simulated an attacking enemy. Table 1 compares the value of today's force-on-force training with today's live fire training. Because the values described are desirable characteristics they can also be considered as objective requirements for live fire training in the 21st Century. Discussions of the criteria and the comparison follow.

Table 1.

Comparison of Training Advantages of Force-On-Force Versus Live Fire Training

| Comparison Criteria | Force-On-Force | Live Fire |
|---|---|---|
| Leadership Development | X | X |
| Practice of Field Craft | INCREASED | X |
| Cope with Friction and Fog of War | INCREASED | X |
| Understand the Impact of Time and Distance Factors | INCREASED | X |
| Engender Confidence in Self and Buddies | X | INCREASED |
| Battlefield Realism | INCREASED | X |
| Individual Competence:<br>w/Weapons<br>W/Equipment | <br>X<br>X | <br>INCREASED<br>INCREASED |
| Safety | X | INCREASED |

Leadership Development

Both live fire and force-on-force training provide significant but hard-to-measure payoffs that other training situations cannot provide. BG Thompson (1999), JRTC Commanding General, believes that experience and maturity are essential in Army leaders. He indicated that the only way for a leader to earn the trust of subordinates and develop self-confidence is through realistic day and night live fire training. Several JRTC O/Cs (1999) stated that unconfident commanders plan ultra-safe training exercises that bear little resemblance to combat. This impacts on the value of the training in terms of developing combat readiness.

Practice of Field Craft

Although present in both forms of live training, force-on-force training provides the better training environment for learning field craft because force-on-force exercises tend to be longer in duration and there are fewer constraints imposed by the need to ensure safe operation of weapons. The use of MILES enables soldiers and commanders to experience the consequences of failure to control fires without actually endangering anyone.

Force-on-force events also provide many opportunities to practice all aspects of living in the field, such as camouflage and concealment, preparation of fighting and protective positions, and working around heavy equipment during conditions of inclement weather and limited visibility.

Cope with Friction and Fog of War

Some leaders believe that live fire training more effectively replicates realism with the friction and fog that characterize a battle. We respectfully disagree. "Friction" has to do with things that go awry. This includes results of enemy action and friendly mishaps such as the courier who gets lost, the company that doesn't leave its assembly area on time and hence misses its line of departure time, and the radio operator who misses or misinterprets a message. There will usually be more "friction" in a force-on-force event such as a field training exercise (FTX) than in a live fire exercise (LFE), since by their nature LFE normally don't cover as much ground or last as long as a FTX. "Fog" has to do with ambiguity, that is, uncertainty about the situation. Battlefield "fog" is probably generated more effectively in FTXs than in LFEs because the FTX opposition force (OPFOR) is a thinking opponent who attempts to achieve battlefield surprise. Further, with LFE, the element of safety constrains how much ambiguity the exercise controller can allow.

Understand the Impact of Time and Distance Factors

COL Lynch (1999) indicates that on the non-linear battlefield, timing is vitally important. Commanders must possess an accurate appreciation of the time required to accomplish tactical tasks such as movement, emplacement of obstacles, repair of damage to permit movement, resupply and rearm, and so on. With the requirement to cover expanded battlespace, commanders will have to make tactical decisions earlier in order to move their forces to points of engagement in time to accomplish their intent. Timing considerations will encompass moving fighting and support vehicles cross-country while contending with chemical weapons effects, enemy obstacles, vehicle maintenance, and the myriad of other problems encountered on the battlefield. Commanders will have to compress the military decision making process (MDMP) in order to seize opportunities or react to threats. Decisions will have to be made on the move with current situation data. Both live fire and force-on-force training events provide all leaders with an appreciation of the factors of time and distance on the

battlefield. However, due to the practical constraints of limited, available live fire impact areas, force-on-force exercises would seem to provide more variety because of the range of terrain where such exercises can be conducted.

Engender Confidence in Self and Buddies

Confidence in self and team members is a high value outcome of live fire training. O/Cs agree that live fire exercises generate far more focus in terms of attention to the tasks at hand among participants than do force-on-force or simulations-based training exercises. Live fire training allows soldiers to develop their own self-confidence, to develop trust in their fellow soldiers and leaders, and to earn the trust of their fellow soldiers and their leaders. Individual soldiers need to understand the effects of live ammunition, understand its effect on the enemy force, and develop trust that their buddies can hit their targets and execute their tactical tasks without endangering others.

Engender Individual Confidence in Weapons and Equipment

Operation of a personal weapon (e.g., a rifle) or weapons system (e.g., a tank) in a live fire tactical exercise permits the soldier or crew to better understand their contributions to the combined arms fight. They also become more used to the noise and flash of their weapon or system, the requirements for safe operation of their weapons or system, and the effects of their physical condition on their ability to effectively operate the weapon or system. In live fire exercises soldiers also gain a qualitatively better understanding of the employment and the effect of supporting weapons (e.g., attack helicopters, mortars, and artillery). The coordinated employment of other weapons systems with one's own requires more than a cursory knowledge of the characteristics and capabilities of that system and extensive training. It is necessary to know the employment parameters of supporting weapons systems and the processes for initiating their employment. The JRTC COG (1999) believes that live fire training helps focus individuals on battlefield tasks, ensuring that each soldier is personally engaged in unit actions. He also believes that, when minimum safe distances of weapons systems are brought into play, soldiers become more cognizant of where they are shooting and of the effects of their fires on the actions of teammates and neighboring units.

## Battlefield Realism

NTC and JRTC force-on-force O/Cs agree that OPFOR and present day force-on-force exercises are far more realistic and flexible than present day live fire exercises in simulating the factors of mission, enemy, time, terrain troops and civilians (METT-TC) that will be encountered in battle. Force-on-force exercises provide realistic freedom to maneuver and to employ fires to defeat a thinking OPFOR across doctrinal distances in real time. During live fire exercises, targets do not shoot back and do not maneuver.

## Safety

Safe operation of weapons can be fully trained only with live fire. We return to the intuitive nature of learning in a live fire exercise. Through participation in live fire exercises, soldiers come to understand the danger of recoiling heavy machinery, become accustomed to backblast and muzzle blast effects, and become aware of the danger to self and others of ricochets and accidental discharges. Force-on-force training which features the use of blank ammunition and MILES cannot provide those sorts of experiences. Simulators cannot fully represent these dangers. The complete range of task steps and performance measures in a battle context can only be provided by live fire training on tasks such as ammunition handling, loading and reloading, and correcting weapons malfunctions. During live fire exercises at the CTCs, O/Cs have noticed better integration of other battlefield operating system (BOS) elements because safety restrictions prevent employment of any system that has not been precisely integrated into the training exercise.

## Current O/C Requirements

We were asked to appraise CTC O/C feedback and exercise control workloads. The comparison of O/C training feedback and exercise control requirements between force-on-force and live fire exercises is shown in Table 2.

Table 2.

Comparison of O/C Requirements for Force-On-Force Versus Live Fire Exercises

| | **Force-On-Force** | **Live Fire** |
|---|---|---|
| Facilitate Achievement of Collective Training Objectives | Same | Same |
| Exercise Control | Tactical Events | Tactical Events and Safety (Less Margin for Error) |
| Delivery of Feedback | AAR - based on MILES/Observations | AAR - based on Tgt Hits/Observations |

We found that the requirement to meet collective training objectives was similar for both types of training. There were some differences in the functions of exercise control. During force-on-force training, O/Cs deal primarily with tactically oriented control requirements while the live fire O/Cs also have to deal with increased safety parameters. There is clearly less margin for exercise control error during live fire training when compared to force-on-force training. Both force-on-force and live fire training exercises are sources of feedback to participating units in the form of AARs and take home packages. The information to enable this feedback comes from the O/Cs' observations and from the CTC's instrumentation. The live fire O/Cs had generally the same instrumentation support, but also provided feedback based on observations and target hits. It should be noted that home station training is similar as concerns feedback and control. Differences between the CTCs and home stations in these areas are those of scale. Units training at home stations normally do not have the quantity and quality of O/Cs available at the CTCs. Units at home stations must rely upon their own leaders, sometimes augmented by O/Cs borrowed from other units, to appraise the battle and to identify training issues in accordance with the precepts of FM 25-100. There is very little, if any, instrumentation at home stations. Unit leaders must reconstruct events based on their observations and reports.

## Proposed Live Fire Training Strategy

### Training Objectives for the Proposed Live Fire Futures Strategy

An Army live fire training strategy is required that prepares the Army's soldiers and units for future combat. The 21st Century may find US units engaged in conflicts that are asymmetric in nature or in conventional warfare that is similar to that of the last decade of the 20th Century. As a result, all units must be able to defend themselves and their activities because there may no longer be relatively safe rear areas. As is the requirement now, all soldiers and crews must be qualified with their individual weapons and fighting systems. The need for live fire training for combined arms operations will continue. In the following paragraphs we propose an Army strategy for live fire training that would meet the foregoing range of requirements. We will identify the tasks, training audiences, and frequency for live fire training in the 21st Century.

Following are the objectives of this strategy.

- Contribute to maintenance of proficiency at individual and collective tasks
- Mitigate the adverse affects of high personnel turnover rates
- Develop competent and confident units (squad - Battalion/TF)
- Develop competent and confident individuals
- Enhance leadership development.

The graphic at Figure 3 portrays our recommended live fire training strategy for the U.S. Army. This strategy provides live fire training for all combat, combat support (CS), and combat service support (CSS) units.

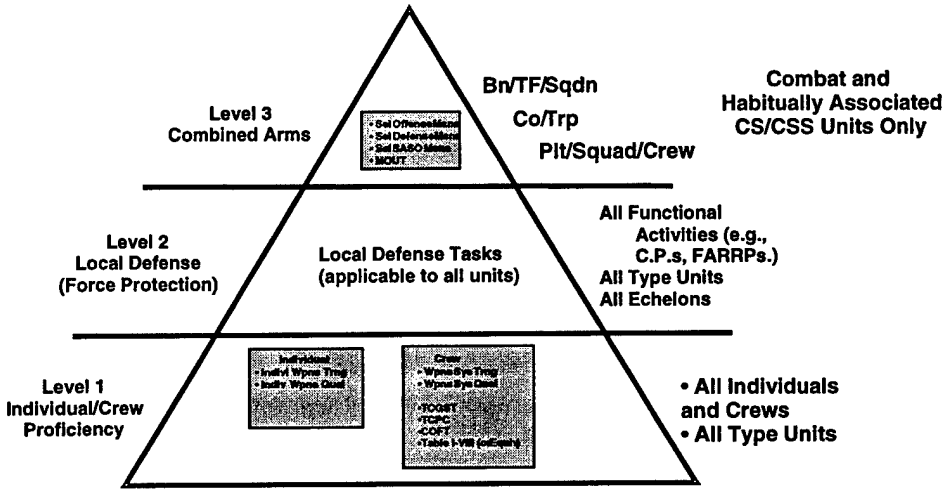



Figure 3. Proposed Army live fire training strategy.

This strategy is designed to gain and sustain proficiency at three levels; individual and crew qualification, local defense for all units and functional activities, and combined arms conventional tasks for battalion task forces. Each level is outlined below.

Level 1: Individual/Crew Proficiency

This is the entry level of the LFF strategy. This level focuses on training individuals and crews. It is roughly the same as current qualification requirements. Training conducted within this level can be conducted at home stations' local training areas and is compatible with present day capabilities. Level 1 focuses on the progressive development of individual and crew proficiency. Basic guidelines for Level 1 include:

- **Training audience:** Every soldier and crew.
- **Objective:** Individual and crew proficiency.
- **Tasks and Standards:** Weapons and systems qualification as prescribed in applicable weapons tables.
- **Frequency:** Every six months or, upon change to composition of crews because of change to key crewmembers (whichever occurs first).

Level 2: Local Defense (Force Protection)

Of the three levels of the recommended strategy, Level 2 is the largest departure from present training practice. Level 2 requires all combat, CS, and CSS units and functional activities (e.g., command posts (CPs) and forward area rearming and refueling points (FARRP)) to perform a defensive task in a live fire event. Every unit and activity on a future battlefield may have to defend itself due to the nature of asymmetric warfare. We concluded that a requirement to perform a local defense task met this criterion. No longer can CS and CSS units assume that the rear area is a safe haven, because there will be no rear. In such an environment, every position, base, base cluster, CP, communications node, convoy, medical facility and so forth is a potential enemy objective. Therefore, the training of a defensive task in a live fire environment seems appropriate for all these types of units and activities. All leaders and soldiers must be proficient at their tasks. Basic guidelines for Level 2 training are:

- **Training audience:** Every squad, section, platoon, company, and functional activities, e.g., CPs, FARRPs, retransmission sites.
- **Objective:** Proficiency at local defense.
- **Tasks and standards:** Defense of a position in accordance with (IAW) relevant Mission Training Plans (MTPs).
- **Frequency:** Every six months or upon change of key leaders or significant personnel turbulence and turnover (whichever occurs first).

Level 3: Combined Arms Training

The focus of Level 3 is the training of combined arms operations. Level 3 live fire training is for combined arms formations from combat platoon/squad/crew through the echelon of Battalion/TF/Squadron. CS and CSS units participate in their normal tactical supporting roles. Tasks to be trained in the live fire mode at this level are conventional offense and defense, stability and support operations (SASO), and military operations on urbanized terrain (MOUT). Guidelines for Level 3 are:

- **Training audience:** Maneuver battalion task forces and squadrons.
- **Objective:** Proficiency at defense, offense, SASO, and MOUT tasks IAW unit mission essential task list (METL) and under appropriate conditions.

- **Tasks and standards:** Attack, defend, SASO, and MOUT tasks IAW relevant MTPs.
- **Frequency**: Every three months for platoons and lower echelons. Every six months for company teams and cavalry troops. Annually for battalion task forces/squadrons.

## Home Station Training Support

Home station training plays a key role in the LFF concept. Both JRTC and NTC live fire O/Cs agree that units are not as proficient in basic squad/crew and platoon tactics as they were a few years back. This observation is consistent with the September 1999 General Accounting Office (GAO) Report to the US House of Representatives' Subcommittee on Military Readiness of the Armed Services Committee. The GAO report (1999) indicated that over 50% of their survey respondents listed personnel shortages/turnover and high OPTEMPOs as the top reasons for being ill prepared for their CTC training experiences.

> "Many units arriving at the training centers cannot take full advantage of training opportunities because they lack the requisite skills to effectively execute brigade-or battalion-level missions, which is the level of training that the centers are designed to provide." ***GAO Report, Sept. 99.***

Sound home station training is required for the mastery of tactical fundamentals prior to operational deployments or unit transition to the more complex missions and tasks performed at major training areas and CTCs. Within this strategy, the role of home station training is to provide the opportunity and time to train the tactical basics for the echelon being trained. JRTC and NTC live fire O/Cs agreed that the essentials for developing quality home station training are:

- attention to the basics;
- time to train;
- repetition;
- varying scenarios; and
- limits to the unit's ability to learn the range layout in advance.

When units arrive at the CTC proficient in the basics, the available training time and extensive resources are better utilized with a corresponding rise in training effectiveness. Our research identified the following issues surrounding current home station training.

## Quality of Home Station Training

> "They no longer come trained and ready but come ready to train."
> *NTC O/C* (1999)

Generally, we found that O/Cs do not have much confidence in the quality of home station training above squad and platoon levels. Ideally, home station training areas should support high quality training of platoons, companies and the task force and brigade combat team (BCT) staffs before units rotate to a CTC. NTC and JRTC O/Cs (1999) agree that CTC training expectations fall short when maneuver units cannot perform actions on contact or battle drills. Home station training generally fails to adequately train companies and battalions in the coordination, integration and synchronization of BOSs.

NTC and JRTC O/Cs (1999) pointed out that poor performance and fratricide are the result when maneuver, CS, and CSS units do not work or train together at home station. O/Cs indicated that units routinely arrive at the NTC and JRTC at low levels of proficiency in squad and crew drills. The result is that valuable CTC rotation time is taken up with training of basic skills.

## Battlefield Realism

Mr. Jack Bull (1999), JRTC Battlefield Effects Coordinator, explains that home station training is unrealistic because live fire ranges there are static. JRTC and NTC Live Fire O/Cs (1999) agreed that battlefield realism is not simulated at home station training areas and that canned training scenarios detract from development of soldier initiative. On home station live fire ranges, soldiers occupy familiar firing points, know where targets are going to appear, and generally do not maneuver as part of their live fire training. In contrast, the JRTC Movement To Contact range causes soldiers to detect target locations, find cover before engaging a target, and confronts them with situations wherein they may not be able to engage all the targets. Additional realism on the training battlefield is achieved at the CTCs when leaders' ability to command and control is degraded, when targets move, when smoke covers the

battlefield, and when the soldier and unit are presented with different arrays of targets.

Realistic live fire training is dependent on development of live fire range complexes that replicate battlefield conditions by providing doctrinally correct and movable target arrays, by simulating battlefield effects, and by providing the unit with the capability to fire and maneuver. Levels 2 and 3 in the proposed live fire training strategy require the capability to manipulate target arrays to train specific missions and tasks. In the future, units should never view the same enemy target array twice during a training event. Target arrays should present the unit with different tactical situations requiring different decisions and solution sets. When appropriate to the training objective, targets should be presented to the unit being trained within a 360-degree continuum to simulate the asymmetric battlefield. Future capability should not reward a unit's prior reconnaissance of the range beforehand so as to "beat the range."

The JRTC COG (1999) told us that factors influencing effective unit live fire training include the extent of support for realistic and demanding live fire training by the chain of command, post range regulations, safety restrictions and interpretation thereof, and the layout of the live fire facilities. Each of these contributes to the capability of leaders to conduct effective live fire unit training.

Range Support Personnel

Home station ranges and support personnel are critical to the success of any home station training initiative. Mr. Steven Parks (1999), Chief of JRTC Range Design and Weapons Safety Criteria, impressed us as the type of range control specialist who uses range regulations to facilitate training opportunities without sacrificing safety. The expertise of successful Range Control personnel should be captured and incorporated into training programs for the next generations of range control personnel. The excuse of range rules should be removed as a reason to avoid conduct of innovative and demanding live fire training. Future live training will rely on commanders and training support experts who can adapt facilities and scenarios within safety and space constraints to devise safe, tactically realistic events.

## Impacts of Force Modernization and Non-Linear Battlefield Tactics

A principal proposition of this study is that accommodating the effects of force modernization and replicating asymmetric battlefield conditions will have a major impact on future live fire training. The requirement to enable units to train the way they fight will require changes to the design of live fire ranges and training areas. The non-linear battlefield is a 360-degree battlespace, populated by mixes of enemy and friendly elements. This differs from a tidy alignment of friendly forces facing a massed enemy. Another force for change results from the capability of the modernized force to occupy and/or control a larger battlespace than heretofore. During our literature reviews and SME interviews, we concentrated on identifying those factors of force modernization and the asymmetric battlefield that would have the most impact on future CTC and home station live fire training. Additionally, we identified their impacts on CTC O/C and analyst roles and functions. The impacts of force modernization and asymmetric warfare are described in this section.

### Force Modernization

Generally, JRTC and NTC O/Cs (1999) had difficulty in defining the requirements for training force-modernized units. Most CTC trainers associate modernized units as those with smaller combat battalions and increased command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) capabilities. We found that the force modernization factors of extended weapons capabilities and ranges, increased weapons effects, and digitization of C4ISR would have the greatest impact on future live fire training. Table 3 identifies aspects of force modernization that will have to be accommodated at home stations and the maneuver CTCs so that modernized units can conduct realistic live fire training with all their weapons and equipment. Discussions of these elements of force modernization follow Table 3. An even more extensive description addressing specific systems is contained in the Live Training Sustainment, Integration and Synchronization Study conducted by Prosoft (1999) for ATMD.

Table 3.

Impact of Force Modernization on training support requirements

| What's New? | Requirements |
|---|---|
| • Extended Weapons Capabilities and Ranges (e.g., laser weapons, LOSAT, Hellfire, Comanche) | • More training area.<br>• Development of sub-caliber devices<br>• Capability to simulate impact and effects<br>• Soldier protective gear<br>• TES to reflect new weapons |
| • Digitization of C4ISR | • Improve O/C situational awareness<br>• Improve range control situational awareness |
| • Increased Weapons | • Replicate effects of bursting radius<br>• Adjust safety fans/buffer<br>• Develop inert |

Extended Weapons Capabilities and Ranges

Future live fire ranges must accommodate the new weapons systems, particularly those with extended ranges and non-line-of-sight attack capabilities that will be found in maneuver units or in units that support them. The JRTC COG (1999) told us that the JRTC can't accommodate the Line-Of-Sight Anti-Tank (LOSAT) weapon, and that they now have problems with HELLFIRE, Stinger, and TOW. These challenges will only become more difficult as weapon ranges increase. Non-line-of-sight weapons will be constrained, as they will still have to follow safety constraints such as the proscription against trajectories that pass over unprotected friendly troops. NTC Live Fire O/Cs (1999) foresee that the two-dimensional targets now in use will be inadequate in the future because of differences in how targets are attacked. Targets will have to have depth as well as height and width. There is a requirement to develop new types of targets to support non-line-of-sight and top-attack weapons. Live fire combined arms training should include the weapons whose effects will be delivered in proximity to the maneuver force or be used to impact on the close-in fight. As a consequence, weapons with extended ranges will require an expansion of training areas to accommodate the distances over which the new weapons will be able to fire, either in terms of

contiguous acreage or with firing sites further away from impact areas at home stations and CTCs.

Digitization of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)

Supporting the training of the digitized force means replicating all the information flow that is generated by the Army Tactical Command and Control System (ATCCS). The use of ATCCS in battalions and larger units will require more detailed scenarios and additional training support. At those levels, information input from Maneuver Control System (MCS), All Source Analysis System (ASAS), Combat Service Support Control System (CSSCS), Advanced Field Artillery Tactical Data System (AFATDS), and Forward Area Air Defense Command and Control (FAADC2) must be provided to a realistic degree and from doctrinal sources. For example, battalions and their subordinate units should receive orders and information through their Force Battle Command Brigade and Below (FBCB2) systems and from their own soldiers. FBCB2 displays must show a full array of Blue and Red displays along with tactical control measures that are normally transmitted by that system. Making the display reflect tactical orders and enemy adjustment to friendly action calls for sophisticated simulations and a small, but skillful training support cell. Obstacle and weather information, nuclear/biological/chemical (NBC) and enemy air warnings, enemy electronic emissions and indirect fire, and civilians on the battlefield should also be represented. OPFOR target arrays must be mixed deftly into the display and must be affected by long range fires, electronic warfare (EW), dynamic obstacles, and other long-range attack assets. Support of fire and maneuver training should include means to force the unit or crew to shift deliberately from digital to voice communications.

Training centers are either not included in equipment fielding plans or have a very low priority for new equipment. Both the JRTC and NTC O/Cs (1999) report that they are falling behind in proficiency on new equipment. NTC O/Cs (1999) said that they routinely see units that come to NTC with new equipment issued just before they departed home station. The JTRC COG (1999) indicated that his O/Cs could not eavesdrop on unit communications to track Blue Force actions and maintain situational awareness.

O/Cs need the capability to assess Blue Force actions and information management in terms of what the unit knew, when the unit knew it, and what the unit did with the information. The

JRTC COG (1999) told us that units can presently use their organic communications and communications security equipment to inhibit O/C capability to monitor or eavesdrop on unit communications. This reduces the O/Cs' ability to anticipate situations where control may have to be augmented for safety reasons and to obtain insights into the unit's strengths and weaknesses. Range Control personnel will require a similar capability in order to accomplish their functions.

### Increased Weapons Effects

A simulated battlefield with weapons firing live ammunition constitutes a unique and essential experience for soldiers. All trainers interviewed strongly believe that if the Army removed or diminished live fire training, its soldiers would enter combat less confident in themselves and their weapons and less trained on core mission tasks than in the past.

Support for live fire training must enable units' use of all organic and supporting weapons. The greater lethality and other characteristics of modern weapons must be accommodated so that soldiers and leaders can appreciate the capabilities and effects of fires available to them. Expansion of live fire ranges and training areas and/or the fielding of realistic weapons effects simulators will be required to enable operation of these weapons or realistic simulation of their effects.

## Non-linear Battlefield Tactics

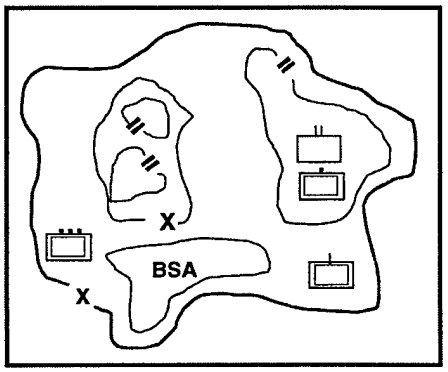
### The Nature of Asymmetric Warfare

The Army leadership foresees that future combat will involve "asymmetric" warfare in which enemies will avoid fighting with conventional units in familiar ways. Burton (1996) implies that the gaining of the asymmetrical advantage will be more important tactically on the future battlefield than identification and seizure of the enemy's center of gravity. Operations on the asymmetric battlefield really mean that the unit must expect conventional and unconventional attacks under any conditions, from any direction, no matter what its mission or location. The Army's future opponents will seek to attack vulnerable forces and facilities while declining direct engagement with US infantry, armor, and aviation units. Threat attacks and ambushes will threaten soldiers and small units everywhere on the battlefield. Similarly, the presence of

infiltrated or bypassed enemy observers will subject high value assets to accurate direct and indirect fire.

The asymmetric battlefield will present training challenges not foreseen in current and evolving training products. In future replications of an asymmetric battlefield, units will have to be able to react to the enemy being anywhere in the unit's area of operation. Live fire ranges will be required that portray enemy forces that appear suddenly behind the leading formations, in the unit rear area, or in attacks on its command posts and logistical elements. Enemy fires may come from any direction to include from areas inhabited by civilians. Meeting engagements, hasty defenses, infiltration and ambushes by both sides will typify asymmetric combat. Figure 4 identifies major characteristics of the asymmetric battlefield.

- Units normally out of supporting range from each other
- Extended frontages
- Local security more important
- Frag orders become more common
- Gaps in coverage
- Less secure Lines of Communication
- 360 Degree Threat
- Civilians on the battlefield
- Increased threat to CS and CSS Elements



Non-Linear/Non-Contiguous/ Asymmetrical

Figure 4. Characteristics of the non-linear battlefield.

The non-linear battlefield will be a complex environment containing different arrays of forces. NTC analysts expect that non-linear operations will continue to require friendly forces to fight deep, close, and rear battles simultaneously. Units, in the future, will distribute their fighting systems throughout the battle area to create depth, maintain security, and facilitate response in any direction. Tactical operations on the asymmetric battlefield require excellent situational awareness to continuously define the enemy and where it is. Table 4 summarizes the characteristics of the asymmetric battlefield that have high impact on requirements for training support.

Training to fight an enemy that employs asymmetric tactics means designing training events in which it is difficult for combat units to fix or strike the enemy. At the same time, all elements of the friendly force should be subject to attack. Ambushes, attacks on CPs and logistics sites, widespread use of mines, and the existence of civilian centers for enemy use as sanctuary areas should all be features of this training. Ranges should accommodate a great deal of tactical movement and maneuver and firing in more than one direction.

Table 4.

Asymmetric Battlefield Characteristics and Implications for Training Development

| What's New? | Future Training Requirements |
|---|---|
| · **360 Degree Threat** | •Reconfigurable, highly mobile targets<br>•Increased size of range areas<br>•Capability to simulate friendly forces on ground<br>•Increased need for target shootback capability |
| · **Expanded Battlespace** | •Increased size of range areas<br>•Linkage of virtual and constructive simulations to live training<br>•Simulation of threat assets relevant to the unit being trained |
| · **Civilians/NGOs on Battlefield** | •Reconfigurable/mobile replication of civilians<br>•Linkage of virtual and constructive simulations to live training |
| · **Non-Specific Weapons Arrays** | •Develop appropriate simulators (e.g., dummy mines)<br>•Simulate RSTA<br>•Increased need for reconfigurable TES |

Following is a discussion and an analysis of the asymmetric battlefield and some of the consequences for training developers.

360-Degree Threat

Command and General Staff College Student Text (ST) 100-40 (1999) describes an asymmetric area of operation as one that exists when one or more subordinate areas of operations do not share a common boundary. The asymmetric battlefield does not have distinctive forward, rear, and lateral boundaries. It is established by a boundary that encloses the entire area. Subordinate boundaries will be continuous, 360 degree arcs that coincide with the unit's area of influence. Units are normally out of supporting range from each other. Future ranges will have to replicate a threat of this nature.

Expanded Battlespace

Future live fire training scenarios will require extended frontages that result in gaps in friendly formations and force units to operate and counteract enemy movements through those gaps. ST 100-40 (1999) indicates that local security will assume greater importance, fragmentary orders will become more common, and friendly reconnaissance to the flanks and rear will have to be continuous. CPs, intelligence collectors, aid stations, unit maintenance collection points (UMCP), radar sites, and all small elements will have to train for active as well as passive self defense.

During his NTC rotation, COL Lynch (1999) assigned 15-km frontages to task forces to defend during asymmetric battlefield scenarios. COL Lynch (1999) indicated that those units could cover that amount of ground if they were provided the enablers that allow them to observe the area and mass effects anywhere within it. From this experience, he indicated that the ability to manage the tempo of the battlespace is critical. If a unit has Joint Surveillance Target Attack Radar System, unmanned aerial vehicle support, and a brigade cavalry troop, it can locate the enemy and determine its rate and direction of movement. This permits rapid tactical decisions and timely movement of friendly units to intercept the enemy at a decisive location. The challenge with this expanded battlespace is maintaining observation over such a large area and massing forces and fires fast enough to meet multiple threats. It will be necessary for training support to provide the cues necessary to stimulate realistic and doctrinally correct levels of monitoring, planning, and directing by unit leaders. This doctrinal expansion of a unit's area of responsibility will have to be accommodated in future training facilities.

Civilians/Non-Government Organizations (NGOs) on the Battlefield

On the asymmetric battlefield, location and impact of civilians and NGOs on the battlefield join obstacle and weather information, NBC, enemy order of battle, indications of future action, and indirect fire capabilities as essential elements of information. More than any time in the history of tactical operations, civilians on the battlefield can represent a tactical disadvantage that must be solved. The battlefield may be in unpopulated areas, or in rural areas, in towns and villages, or cities. Tactical operations may have to commence as the units deploy. At the NTC, live fire O/Cs (1999) believe that asymmetric operations should begin immediately as a training unit arrives at the equipment draw area by having "civilians" demonstrate and cause disturbances as they debark transportation. Training scenarios will be required that will distract US soldiers' attention with civilians on the battlefield (civilians, wounded women and children, etc.) to a level not portrayed in current training.

Non-Specific Weapons Arrays

The types and levels of threats on the emerging asymmetric battlefield are becoming more numerous. Previously we could count on facing a Soviet or Soviet-surrogate threat using exported Soviet tactics and equipment. That is no longer the case as potential threats have a potential arsenal of conventional and non-conventional weapons capabilities. With the proliferation of weapons sales on the international market, US forces require the capability to train against multiple threat capabilities. This implies that the future live fire range must possess the capability to rapidly "re-tool" its threat formations and equipment to respond to pre-deployment training requirements.

Impact of Force Modernization and the Non-Linear Battlefield on CTC O/Cs

The O/Cs coach and mentor unit personnel during training exercises, monitor and assess performance, and help provide feedback in AARs. In support of exercise execution, O/Cs also perform exercise control functions to help ensure safely conducted, effective training. Table 5 summarizes the impact of force modernization and the asymmetric battlefield on O/C responsibilities and organization. Following is a discussion and analysis of some of the factors affecting O/Cs.

Table 5.

Effects of Force Modernization and the Asymmetric Battlefield on O/Cs

| What's New? | Requirements |
|---|---|
| ▪ Extended Weapons Ranges. | ▪ Increased number of O/Cs.<br>▪ Location Indicators. |
| ▪ Greater dispersion of friendly forces. | ▪ Increased number of O/Cs.<br>▪ Location Indicators. |
| ▪ Digitization of C4ISR. | ▪ Capability to monitor unit C4ISR equipment (anticipate unit actions for safety, control, and AARs). |
| ▪ Requirement to vary METT-TC to support specific mission requirements. | ▪ Support mission rehearsal exercises at CTCs.<br>▪ Capability to rapidly develop and reconfigure scenarios, OPFOR (equipment, uniforms, and TTP), civilians and NGOs. |
| ▪ Rapid improvement in information technology. | ▪ Capability from a field location to assess lessons learned in order to coach, mentor observed unit. |

Extended Weapons Ranges

The extended ranges of emerging weapons such as LOSAT and HELLFIRE require O/Cs to adjust their procedures and processes to provide feedback on the employment and effectiveness of each weapon system. There are increased O/C resource requirements to accommodate the tactical employment of extended range weapons. For example, monitoring indirect fire is a responsibility of the forward O/Cs. These O/Cs, most likely supporting the battalion or brigade scout platoon or a forward maneuver company, are currently in positions to observe this fire as a consequence of supporting their normal unit on its battlefield location. With weapons firing at extended ranges, these forward O/Cs may be unable to see the impact of these rounds and assess their effectiveness. This will necessitate additional O/Cs to specifically observe such firing events. These additional O/Cs will either be additions to current Operations Groups'

structures or will be diverted from other O/C duties to perform this function. These challenges will only get worse as weapon system ranges increase.

Greater Dispersion of Friendly Forces

With the requirement to cover expanded battlespace, commanders will further disperse their forces. O/Cs will no longer be able to provide the level of mutual support/observation of adjacent units that they can today. Commanders will make tactical decisions earlier in order to maneuver their forces to points of engagement in time. We anticipate that this will force command and control O/Cs to remain in one CP or location throughout the mission rather than cover multiple CPs as they do today. Commanders will compress the MDMP in order to seize opportunities or react to threats. They will make decisions on the move with current situation data. This faster level of operating tempo (OPTEMPO) will influence the locations of O/Cs and necessitate a capability to eavesdrop on units' transfer of information using modern C4ISR equipment.

Digitization of C4ISR

It is significant that CTCs are either not included in equipment fielding plans or have a very low priority for new equipment. The JTRC COG (1999) indicated that his O/Cs could not eavesdrop on unit communications to track Blue Force actions and situational awareness. O/Cs need the capability to assess Blue Force information management, what they know, and what they use. They need this capability to not only gather data for AAR feedback sessions but also to support exercise control functions.

With emerging technology, NTC O/Cs (1999) identified consideration of high/low equipment mix with National Guard and United States Army Reserve units, as well as joint and combined operations as critical elements of the impact of emerging C4ISR capabilities on future live fire training. Routinely, units link up with other supporting units at the NTC. More often than not, the principal combat unit has digital capabilities and new equipment while the supporting unit does not. The presence of a non-modernized unit in a task organization tends to complicate the O/Cs' task of maintaining awareness of the situation and unit plans.

Requirement to Vary METT-TC to Support Specific Mission Requirements

It is anticipated that units' requirements for mission rehearsal exercises will increase as the US continues to deploy forces for missions similar to that ongoing in Kosovo. Creation of conditions to replicate specific METT-TC will require agility in CTC operations and support. New scenarios will have to be created. The OPFOR will have to be able to adapt its uniforms, doctrine, tactics, and weapons. Weapons characteristics replicated by MILES will not be the only aspect of weaponry that might have to be varied depending on the source of the probable opponent's armament. Mines and booby traps vary extensively depending on the source. Target arrays for live fire exercises will also have to be easily changed to fit the variety of situations likely to be portrayed.

Rapid Improvement in Information Technology

The rapid pace and multiple aspects of the asymmetric battlefield and force modernization will probably necessitate the requirement for O/Cs to be able to assess doctrine, tactics, techniques, and lessons learned without assistance from analysts dedicated to that purpose. Instrumentation imbedded in organic tactical systems could provide the bulk of data required for presentation during AARs. Future instrumentation systems working with embedded simulations should have the capability to reduce the role of the analysts and "automate" aspects of AAR development. The CTCs and home station trainers will then require the capability to draw from Army-wide lessons learned and techniques as well as information not collected in the tactical systems and instrumentation in order to coach and mentor the observed unit. As a consequence, an improved instrumentation and AAR information collection system could expand the capabilities of O/Cs and training analysts.

## Impact of Force Modernization and the Asymmetric Battlefield on Training Analysts

Branch proponent subject matter experts have important roles in the analysis of training at the CTCs. These individuals are usually known as training analysts. The analysts appraise the data produced by an extensive instrumentation system for relevant data to support AARs. Table 6 summarizes the major effects of force modernization and asymmetric battlefields on the jobs of analysts. A discussion of these factors is provided following the table.

Table 6.

Impact of Force Modernization and the Asymmetric Battlefield on CTC Analysts

| What's New? | Requirements |
|---|---|
| ▪ Increase in tactical friendly/enemy data known to unit through C4ISR. | ▪ Quick access to new information for timely analysis and AAR preparation.<br>▪ Capability to earmark information to battlefield timelines and sequence of events.<br>▪ More reactive systems to support training analysis.<br>▪ Instant training feedback. |
| ▪ Linkage of constructive/virtual simulations to live training. | ▪ Rapid capability to interface with multiple systems for analysis. |
| ▪ Rapid improvements to information technology. | ▪ Rapid link to CTC trends and lessons learned to relate to unit AAR.<br>▪ Need to incorporate data of the unit's performance into other databases for analysis of trends. |
| ▪ Requirement to vary METT-TC. | ▪ Capability to rapidly alter analytical models. |

Increase in Tactical Friendly/Enemy Data Through C4ISR

Two previous studies conducted by ARI for ATMD (Brown et al., 1998; Brown, Anderson, Begley II, and Meliza, 1999a) concluded that, in the absence of interventions, digitization may necessitate more training analysts at the CTCs. In the digitized training environment, platoon and company level O/Cs need to know when digital FBCB2 messages or overlays are sent, the content of the messages, and the identity of senders and receivers; however, the O/Cs would prefer to task analysts with tracking those communications.

NTC training analysts (1999) receive their data either by voice from the O/Cs and/or electronic transmission from the instrumentation system. The analysts then transform this data into AAR material and take-home packages. Development of AAR data is always rushed because of time constraints. CTC analysts also have the requirement to relate the nature of information inputs and subsequent decisions to the sequence of OPFOR and Blue Force actions. That requirement exacerbates the challenge of appraising the battle. Time available will be compressed even more as improved C4ISR equipment increases the amount of information available and shortens decision cycles. CTC analysts will receive more data with less time for analysis and AAR preparation.

Linkage of Constructive/Virtual Simulations to Live Training

Future CTC analysts may be required to collect data not only from the Centers' instrumentation systems to document the fight, but also from a combination of virtual and constructive simulations. Furthermore, the live fire exercises themselves may also involve some degree of engagement simulation. Sophisticated linkages between live, virtual, and constructive simulations will be necessary to permit a "seamless simulation" and to facilitate the flow of battlefield information across these linkages.

Rapid Improvements to Information Technology

The rapid pace and complexity of the future battlefield will require training analysts to be able to rapidly link data bases so as to be able to interpret battlefield events in the context of doctrine, tactics, techniques and procedures, and CTC trends and lessons learned. They will then have to quickly relate the foregoing to the unit AAR. Instrumentation embedded in organic tactical systems will continue to be able to provide the bulk of data. Instrumentation systems, embedded simulations, and rapid improvements in information technology make it feasible to reduce analysts' workloads by providing O/Cs with access to the data and the capability to manipulate and interpret the data themselves.

Requirement to Vary METT-TC

The types and levels of opponents that US forces may encounter are growing. With the proliferation of terrorism and other threats throughout the world, today's US forces require the capability to train against multiple enemy capabilities in a

range of scenarios. This implies that in the future, training analysts will require the capability to rapidly alter their analytical models. They will require the capability to quickly "re-tool" their databases to meet the needs of rotating units preparing for specific deployments.

## Military Operations on Urban Terrain

Home stations and the CTCs will have to be able to support units' training requirements for MOUT. A major consideration for future live fire training will be the training of MOUT tasks. With increasing urbanization and the perception that fighting in cities offsets US advantages, MOUT demands more attention from trainers and commanders than in the past. Mordica (1999) and Peters (1996) both describe MOUT operations in terms of an environment that will be even more complex and dangerous than just few years ago. Potentially hostile elements have a propensity to select urban terrain for armed conflict. There has been a dramatic increase in the variety and lethality of weapons available to them. Mordica and Peters suggest that the United States will be required to cope with advanced technologies that re-invent themselves in hours, days, and weeks. Army doctrine and units will have to adapt to this challenge.

FM 101-5-1, Operational Terms and Graphics, defines MOUT as "all military actions planned and conducted on a topographical complex and its adjacent natural terrain where man-made construction is the dominant feature." It includes combat in cities, which is that portion of MOUT involving extensive building-to-building, house-to-house, and street-by-street fighting. With the exception of large-scale amphibious assaults, combat under the conditions of MOUT may be the most complex of all military operations. MOUT training will have to be adaptable to replicate urban areas of all sizes, from shantytowns to villages to large cities.

MOUT is currently included in the live fire scenarios at both the NTC and JRTC. Tasks include planning for MOUT operations and attacking the OPFOR in a village. Live fire MOUT training is more extensive at the JRTC than at the NTC.

Cameron (1997) reinforces the international consequences of MOUT operations with his analysis of Israel's 1982 invasion of Lebanon. As the Israeli Defense Force (IDF) attempted to drive the Palestinian Liberation Organization (PLO) out of Lebanon, the PLO withdrew into the cities using the urban setting to

offset its lack of sophisticated weaponry. The urban setting also suited the PLO's decentralized tactical leadership. Structurally and doctrinally ill equipped for urban fighting, the IDF could either use artillery and air power to crush resistance in cities still populated with civilians, or it could use scarce infantry in slow and costly clearing operations. Initial Israeli use of blanket firepower brought international condemnation.

Peters (1996) makes a strong case that present MOUT training tasks, conditions, and standards only prepare soldiers to fight in villages or small towns, not in cities. Peters (1996) visualizes future MOUT operations requirements in the streets, sewers, high-rise buildings, industrial parks, and the sprawl of houses, shacks, and shelters that form the cities of our world. This "city" MOUT environment will be defined by being more vertical; it will extend from skyscrapers down to sewers. There will be increased difficulty in maintaining an accurate picture of a multidimensional urban battlefield. The ruins of city infrastructure will change terrain analysis and impede movement. Attack angles will often negate field artillery capabilities. Further, armored vehicles will be less effective in cities while unarmored vehicles will be more vulnerable. Future MOUT sites will have to be more complex in order to simulate a city environment.

As we researched the implications of MOUT for future live fire training, it became clear that the MOUT environment will necessitate development of doctrine, tactics, and procedures. Weapons and equipment will also change. These changes will influence the design of support for force-on-force and live fire training.

Thermobaric weapons are a relatively new and highly dangerous blast effect weapon. A rocket launched warhead containing a thermobaric (heat + pressure) explosive mixture destroys its target with a brief but intense fireball that produces an over-pressure shock wave that is lethal when detonated inside a building. The effects of the fireball and shock wave are magnified and channeled, enabling one or two rounds to engulf and gut several rooms, passageways, or stairwells at once. Cramped confines will greatly magnify the effects of thermobaric blasts at close-quarters. In the cities, thermobaric weapons may in fact become every bit the force-multiplier for the potential enemies that armor and air power have historically been for US forces on the relatively open terrain of Europe and southwest Asia. Future engagement

simulators will have to include the effects of thermobaric weapons.

Peters (1996) and Mordica (1999) each conclude that MOUT operations in large cities will require that communications equipment be issued to individual soldiers. Mordica (1999) points out that specialty communications equipment is now only available to special units. This communications equipment is needed now for regular infantry for training and combat operations. Future instrumentation will have to be designed to operate in an environment of large volumes of tactical voice transmissions.

Urban operations require that infantrymen be highly trained to do more than clear buildings by fighting one room at a time. They will also have to defend these buildings and secure lines of communication. In an urban battle today, the fight for a building may take place 24 stories straight up or several levels under the ground. Battlespace cannot be considered solely in dimensions of ground area; vertical dimensions must be addressed. A battle fought in urban terrain lessens the advantages that the US military possesses on the open battlefield. Soldiers, not machines, are required to fight for every street corner, each set of stairs, each hallway and each room. Such tactics will require flexible target arrays.

JRTC force-on-force O/Cs (1999) were emphatic that every light infantry installation needs a MOUT live fire training facility. Present training sites are unrealistic for training large city MOUT tasks. Units need to be able to change the design and formation of MOUT constructions by moving walls and obstacles in order to change the situation, thus eliminating predictability.

## Notional Live Fire Range Concept

### Range Development Characteristics

We were asked to develop a concept for future live fire ranges that would address the issues identified in this study. Our first step was to identify required characteristics to guide us. Following is a discussion of the characteristics that we attempted to accommodate in our concept for a notional live fire range to meet future live fire training requirements.

### A Realistic Battlefield Environment

In terms of conditions, future live fire training should resemble combat more closely with the inclusion of environmental accompaniments of combat -fires, tracers, noise, dust, random movement and smoke - on all but the most basic courses. The enemy and civilian personnel should be part of training scenarios. Unforeseen changes in orientation and mission combined with unpredictable sequences of engagements should be routine and easily implemented. The events should be adaptable to the various levels of proficiency of the training audience.

Future live fire ranges should have state-of-the-art special effects suites with specialists to orchestrate battlefield effects. To improve realism, future live fire training areas should present realistic battlefield clutter (smoke and fire, destroyed vehicles, ruined structures), civilians, animals, electronic interference, and realistic levels of noise and obscuration. The sights and sounds of battle should be realistic. STRAC allocations of pyrotechnics and explosion simulations should be increased to support live training.

Three-dimensional target systems are required because of the unpredictability of orientation when engagements occur. Simulators that replicate the effects of friendly and enemy indirect fires and enemy direct fire should be available. The Army should be able to replace the human fire markers now in use as the capability to replicate weapons effects is improved.

Range control personnel of the future will have to be problem solvers who can find innovative ways to safely support live fire training with existing facilities as units seek to train for specific METT-TC.

Freedom to Maneuver

Units should be free to fire and maneuver as the situation dictates. The future live fire range will have to allow for larger tactical areas of responsibility than at present. A truly non-linear battlefield will pose threats from many quarters and will require units to fire in more than a single direction. Units and crews should have greater freedom of movement during live fire training and should be called on to make short-notice moves of several kilometers to train to the requirement for fast movement between fights. Time-distance effects on the expanded battlefield should be represented by longer ground distances for activities like resupply, cross attachment, repositioning of sensors, relocation of FARPs, etc. We anticipate it would take a major revision of range regulations to achieve the capability to accommodate asymmetric battlefield maneuver and movement requirements.

Accommodate a Variety of Weapons

Generally, increased ranges of weapons systems present the greatest challenges to development of live fire ranges at both CTCs and home stations. Current home station ranges are rarely suitable for training above company level. Land expansion initiatives at both the NTC and JRTC will increase capabilities to train in a non-linear battlefield environment.

One of the biggest stumbling blocks to development of the future live fire range is accommodation of non-line-of-sight weapons. We can anticipate that the variety of weapon systems capable of firing in a NLOS fashion will increase greatly and extend down to the level of an individual vehicle or soldier. The primary affect that NLOS systems will have on live fire training is the requirement for sufficient land and space to fire the weapons. Both NTC and JRTC use all the land that they have now and still experience major limitations. For example, MLRS is fired at the JRTC, but only at minimum range. Stinger and Avenger are fired but only under waivered conditions. A waiver has to be issued when maximum or minimum-firing criteria are identified. This waiver allows the unit a one-time deviation from normal target engagement rules, but is closely watched by range control safety personnel. Obtaining a waiver is a time intensive process and normally results in severe restrictions on the tactical flexibility conditions for firing the weapon.

The introduction of Comanche battalions to CTC training environments will require change to accommodate that weapon system. The millimeter wave radar on the Comanche and Hellfire missile will also present a significant challenge. Evolving weapons technology creates special safety problems that must be addressed by range control personnel.

Parks (1999) told us that normally there are few or no data references available to training supporters when weapons are initially fielded. Range control personnel presently have to conduct their own research with the weapons systems developers to identify the required data on noise, soil contamination from depleted uranium rounds, etc., so that they can develop parameters for use of the weapon or system in training. New weapons system data is critical to range control planning to establish firing points, footprint data, bursting radius, etc. Data on weapons systems is required a minimum of one year in advance of fielding to allow for planning, designing, and building a new range complex. Information technology should be exploited to permit range control personnel to rapidly process "new" requirements generated by force modernization and units' efforts to train under the conditions of specific METT-TC.

The future live fire range must be designed or redesigned to accommodate increased weapons capabilities and new training tasks, conditions, and standards. The future live fire range should provide the capability to engage targets at longer range, permit non line-of-sight and line-of-sight engagements, recover depleted uranium rounds, etc.

Accommodate Non-lethal Weapons

Interjecting non-lethal weapons on the future live fire range will be a challenge. For Blue players in force-on-force events to use and experience the enemy's use of some non-lethal effects, new training aids, devices, simulators and simulations (TADSS) will be necessary. A system that imposes communication kills and mobility kills will go some distance toward this goal by giving trainers a way to introduce EW, directed energy weapons (DEW), and counter-mobility weapons. Counter-optics and electro-magnetic pulse (EMP) weapons are harder to simulate and would require a training system that could shut down weapons sights, NVGs, navigation aids and other radio equipment without damage to them. Employment of hallucinogens, acoustic weapons, and DEW isn't feasible because of safety considerations, though individual soldiers could wear equipment that would receive and transmit signals to indicate the use of different types of

weapons and to permit assessment of casualties in a manner similar to MILES.

Smart/Intelligent/Brilliant Weapons

Smart weapons are those with the capability to designate targets with lasers or by other means. They can include, but are not limited to signature seeking ammunition (heat, laser, sound, etc.), smart minefields that allow some mines to be contact detonated while others are command detonated, and the capability for weapons to use targeting data when aiming. Smart weapons that must be considered for inclusion on the future live fire range are precision guided missiles (PGMs) and area denial/area coverage weapons. PGMs include guided missiles and guided mortar shells and field artillery (FA) rounds, top attack artillery weapons, standoff systems delivered by rocket or aircraft, cruise missiles, discriminating mines and some robotic weapons. Area denial/coverage weapons are clustered munitions, scatterable mines, and chemical-biological weapons. Training in their employment and battlefield effects will be a critical requirement.

Training to use smart weapons and to cope with the enemy's use of them requires new signature devices. TADSS are required that activate laser alarms and cue passive and active defense systems. O/Cs and analysts are likely to be heavily involved in deciding when targets should emit various signatures. "Kill" mechanisms similar to remotely activated MILES will have to be on hand to permit control cells to selectively kill the targets of smart weapons.

Capability to integrate seamless live, virtual, and constructive training

The future live fire training range will be required to electronically integrate players in diverse locations who are using different training environments. The future live fire range will allow entire units to participate in the training event with only selected elements actually occupying the live fire range. The capability to integrate live, virtual and constructive training capabilities provides the commander with multiple, cost saving options to train his entire task organization.

## Cue Modern ATCCS Equipment

The future live fire range will have to replicate the sources, volume, and fidelity of information available to modernized units. Information should be delivered to the units' ATCCS equipment in the form and from the sources that will be available to the units when deployed for operations. The information infrastructure supporting the future training facility must activate all the ATCCS systems assigned to the unit with a smooth blend of actual and simulated forces.

## Combined Arms Training

The Training Analysis and Feedback-Center of Excellence (TAAF-X) study indicates that FTXs usually entail units training without the complete use of "slice" elements that comprise a combined arms team (Anderson, Begley II, Arntz and Meliza, in preparation). The fact that units at home station often train without all the "slice" elements of a combined arms team is evident when these units train at the CTCs.

The live fire range of the future must provide the opportunity for combined arms forces to train together. Training with habitually associated "slice" units is preferable. However, training with "slice" units of the same type would be acceptable. Combined arms must have the opportunity to refine procedures for coordinating, integrating, and synchronizing the employment of supporting assets and perfecting tactical maneuver skills applicable to the echelon. Future live fire ranges should provide the opportunity to exercise combined arms command and control of the combined arms and services units, refine unit standing operating procedures (SOPs), and reinforce crew/unit gunnery skills with the additional aspect of organic and combined arms fire control requirements.

## Adaptable Threat Target Arrays

Future live fire ranges should provide realistic and movable target arrays that can be easily arranged to support training specific missions and tasks. Units should never view the same target array twice during a training event. Such a capability will challenge units and contribute to the development of adaptive leaders. Targets also should be equipped with capabilities to sense the training unit's activity and engage it with MILES. Target arrays should also be able to simulate maneuver and realistic volumes of fire in response to the training unit's fire and maneuver.

## The Concept for a Notional Live Fire Range

We used three parameters to develop a notional live fire range that would encompass the above characteristics. First, use capabilities that are available today or, are feasible to achieve in the future. Second, combine FTXs conducted with live fire and simulations-based exercises, both virtual and constructive. Third, leverage the training capabilities already existing in MTPs and home station/CTC training facilities.

The foundation of this concept for a live fire training facility is the linking of constructive and virtual simulations with live training. The best features of four different training environments (live, virtual, constructive, and hybrid[1]), linked so as to be integrated and mutually supporting, are employed to enable realistic and stressful training in accordance with the training strategy proposed earlier. (Figure 5)

The top level of the proposed Army live fire training strategy encompasses training events that are the most difficult to support at home stations. Since it is not realistic to significantly expand or improve local training areas at home stations, we suggest the solution is to develop range facilities at several training areas (e.g., Gowan Field, the NTC and JRTC) that can be used by a number of units. Development would incorporate a Synthetic Theater of War (STOW)-like linkage of training sites and improved live simulation (targets, weapons effects, etc.) as described earlier. The middle and bottom levels of live fire requirements can be supported with the range areas and facilities that are available at most sites today, although enhancements in the form of reconfigurable targetry and so forth will be needed to generate the capability to employ a variety of scenarios. Linked simulations provide the capability for unit commanders and staffs to accomplish critical integration and synchronization of all elements since the simulations permit the participation of the commander's entire

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[1] Keesling, King, and Mullen (1998) define a hybrid environment as a linked combination of live, virtual, and constructive environments that may be distributed using a common synthetic battle space. They cite the Synthetic Theater of War-Europe (STOW-E) and Army Experiment III as examples of the hybrid environment. They also point to blends between live and virtual environments. The Tank Weapons Gunnery System and the Precision Gunnery System both use devices to simulate weapons fire, and lasers to simulate appropriate effects on opponent vehicles. Embedded training systems built into combat equipment will allow units to train on their actual equipment in response to simulated situations.

combined arms force. Through the use of virtual and constructive simulations, the entire battalion task force or even a brigade combat team can participate in executing the mission while only some elements perform their tasks using live fire. Soldiers and units would interact with other units/teams through links between simulations that would also replicate the battle area and provide relevant information about the situation to all units.

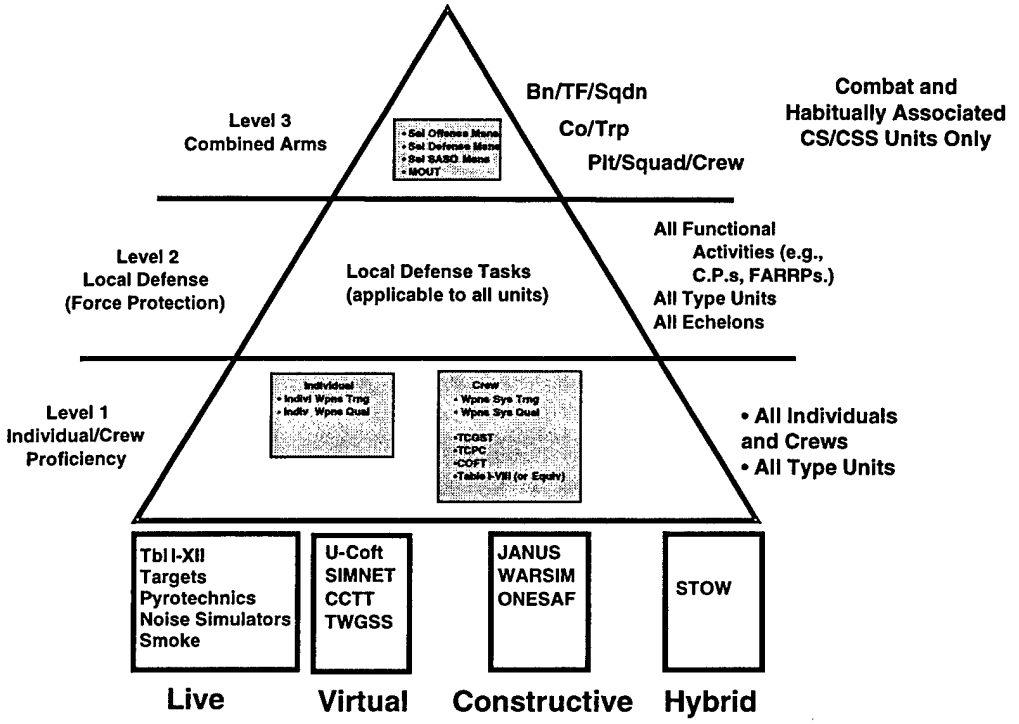


Figure 5. Execution of proposed live fire training strategy supported by simulations.

STOW already allows the linkage of habitually associated "slice" elements located at different installations through using a combination of live, virtual, and constructive training. The combination of live, virtual, and constructive training environments will allow habitually associated units located at different installations to train together "virtually" without having to be at the same location at the same time. This concept provides the increased training benefit of having all of the "slice" elements participate. Support from types of units unable to participate in the training event would be provided

electronically by surrogate units that would play from the appropriate branch proponent school's location.

The notional live fire range for the future has two essential components that depend on continued advances in technology. Externally, the range is electronically linked to simulation centers located at units' home stations and the TRADOC proponent schools. The range would also be linked to those local training areas capable of supporting force-on-force training. The other essential component is the range's infrastructure, which should provide the capabilities or features as follows:

- local area "digital" network that will permit units to "plug-in" their C4ISR systems in a doctrinal context and receive integrated information for their areas of operation -- to include doctrinal distances beyond the limits of the range area;
- simulation of a variety of enemy formations and tactics;
- the presence of civilians if consistent with the unit commander's training objectives;
- fire and maneuver of friendly elements that for reasons of safety cannot maneuver in accordance with the commander's intent at some point while performing the mission (e.g., maneuvering to the rear of the objective while other elements are firing at the objective);
- an OPFOR shoot-back capability;
- weapon effects that match the unit's weapons and those of the OPFOR consistent with contingency planning METT-TC;
- realistic battlefield sounds and sights;
- a range of natural and man-made obstacles that will support the commander's training objectives; and
- instrumentation to support training assessments, such as position locations, engagement ranges, hits, and misses.

Our notional live fire range will permit combined arms units to train at level 3 of the proposed Army-wide Live Fire Training Strategy conventional offensive and defensive tasks, MOUT tasks (which could be under conventional warfare or SASO

conditions), and SASO tasks. The same ranges could be used for live fire training by all types of units and activities of the defensive tasks identified in Level 2. We envision, however, that most local range areas now available will support Level 2 live fire training.

Table 7 provides a comparison of the training advantages of current and proposed future live fire training ranges in terms of the same criteria we used to compare live fire and live force-on-force. In most cases the training value of the future live fire range is greater than that of the current range. The results of the comparisons on each of the criteria are described below. In general, the increased benefits of the future range are gained by increasing various aspects of combat realism. Increased realism is made possible by creating a less predictable enemy and friendly situation, by allowing greater simulation of the fog of war, by allowing greater participation of various combined arms elements, and by enabling a non-linear battlefield situation.

Table 7. Comparison of Training Advantages of Current Versus Future Live Fire Ranges

| **Comparison Criteria** | **Current Live Fire** | **Future Live Fire** |
|---|---|---|
| Leadership Development | X | INCREASED |
| Practice of Field Craft | X | INCREASED |
| Cope with Friction and Fog of War | X | INCREASED |
| Understand the Impact of Time/Dist Factors | X | INCREASED |
| Engender Confidence in Self and Buddies | X | X |
| Battlefield Realism | X | INCREASED |
| Individual Competence:<br>w/Weapons<br>W/Equipment | <br>X<br>X | <br>X<br>X |
| Safety | X | X |

Leadership Development

To a large extent the future live range concept will address the problem of leaders restricting realism and taking actions or not taking actions because of safety as opposed to

accomplishing their tactical tasks safely. The use of adjacent and supporting forces that are represented by forces in another training environment allows leaders to conduct exercises where firing is less constrained than in many current live fire exercises. At the same time, the 360 degree battlefield of the unit using live fire and mixing of environments should result in a more complex tactical situation with increased opportunity for leaders to develop tactical skills. The future live fire range concept calls for an enemy situation that is less predictable than that found on ranges where units may have prior knowledge of the disposition of targets. The future range would also allow for less predictable behavior on the part of supporting and adjacent units. Both of these variables act to create an environment where leaders can employ live fires in a more realistic setting than current ranges, without creating undue safety problems.

Practice of Field Craft

Future live ranges will provide soldiers with a better opportunity to practice selected elements of field craft. Namely, the capability of the enemy to engage friendly units with a MILES-like system will force soldiers to move as if they were under direct fire, using correct movement techniques and tasking advantage of cover and concealment.

Cope with Friction and Fog of War

Future live ranges will allow for more situational ambiguity to be included in an exercise without creating major safety hazards. The trainer would be free to create or add more friction and fog than is possible with current live fire ranges without creating safety problems. The less predictable behavior of enemy and friendly forces in the future live fire range, and the capability to employ a non-linear battlefield situation, would also add to the friction and fog of war.

Understand the Impact of Time and Distance Factors

Increasing the number and types of units participating in a live fire exercise increases the complexity of integrating and synchronizing unit activities. Although these other units may be participating in the exercise via virtual or constructive simulations, the necessity of orchestrating the participation of each unit presents a tough challenge.

Engender Confidence in Self and Buddies

As mentioned in our comparison of live fire and force-on-force environments, live fire gives soldiers greater confidence that they and their buddies can "hit their targets and execute their tactical tasks without endangering others."

Engender Individual Confidence in Weapons and Equipment

Future live ranges will provide the same opportunities as current ranges for soldiers to see how their weapon contributes to the mission and to practice safe operation of their weapon. In comparison with the current CTC environment where at least selected supporting live fires are included, the future range may provide soldiers a reduced opportunity to see the effects of supporting fires and experience friendly rounds firing safely over their heads. On the other hand, effective integration of live and virtual participants in exercises will provide information about the damage done by supporting fires that is not available in most current live fire exercises.

Battlefield Realism

A less predictable enemy situation, the capability for the enemy to return fire, a non-linear battlefield, and greater play of combined arms contribute to increased battlefield realism for future live fire ranges.

Safety

Training in safe operations of weapons and equipment will be as effective in the future live fire environment as it is today. There will be a degradation to the extent that some of the combined arms only practice tasks in the virtual mode. As previously mentioned in this report, CTCs, O/Cs have noticed better integration of BOS elements during live fire exercises because safety restrictions prevent employment of any system that has not been precisely integrated into the training exercise. Having combined arms weapons simulated in the virtual environment is not expected to offer the same benefit; however, very few current live fire ranges support exercises in which a significant portion of the combined arms elements can fire in the live mode. For the typical situation, the future range will at least allow for more combined arms elements to participate, although in the virtual mode. In this case, proper integration of live, virtual, and constructive environments will allow for mistakes to occur with consequent simulated fratricides.

Lessons learned should result in an increase in the ability of units to employ their weapons in a safe manner.

Examples Live Fire Exercises on Future Notional Live Fire Ranges

Notional training exercises at the company team level and battalion task force level are used to illustrate our concept of future ranges. The TAAF-X concept would support training exercises with automated AAR product support for BDE/BN TF down to CO/TM level training. The TAAF-X support would be provided to our notional ranges from on-site facilities or from a central facility that supports all the notional ranges. In our examples, we have located such a TAAF-X at Ft. Leavenworth, KS.

## Example A, Company Team Attack

### Task Organization

The number and types of units normally associated with company-team level training are identified in Figure 6. The company team in this example is formed by task organizing one mechanized infantry platoon and two tank platoons. An artillery platoon will provide direct support. Other units supporting the company are an engineer platoon, an air defense section, and a military intelligence section. Additionally, the company CP, combat trains, and elements of the field trains will participate in the training event.

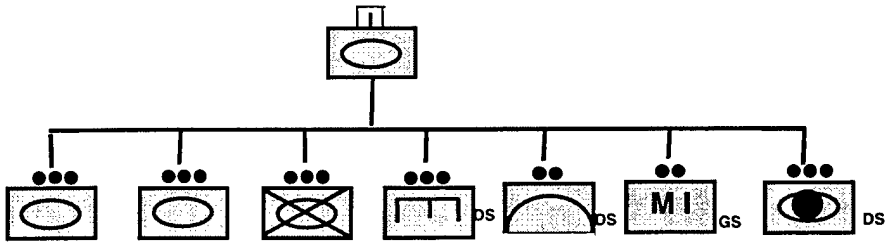


Figure 6. Company team task organization.

### Training Concept

In this example (Figure 7), the company team's battalion CP is located at Ft. Hood, TX. Two platoons are deployed to Gowan Field, ID with the company team CP. The elements at Gowan Field will conduct the live fire portion of the attack. The remaining platoons, support units, and battalion headquarters will participate from Ft. Hood using either virtual or constructive simulations. The first training option for those habitually associated support units stationed at Ft. Hood would be to

participate in the attack from Ft. Hood, using either live fire ranges, maneuver training areas, or the Ft. Hood simulation center. However, if those units were not available, surrogates for them furnished by the branch proponent schools would participate via linked simulations. This capability to use surrogates is necessary so that the company team commander will be able to monitor, plan, and direct the actions of all of the elements or types of units that will be with him in combat. (For example, Air Defense support could be provided from Ft. Bliss, TX. FA support could be simulated from Ft. Sill, OK. Some Engineer support would be furnished from Ft. Leonard Wood, MO. Military Intelligence support could come from Ft. Huachuca, AZ.) Analytical support would be provided to the unit commander from Ft. Leavenworth, KS, using TAAF-X capabilities.

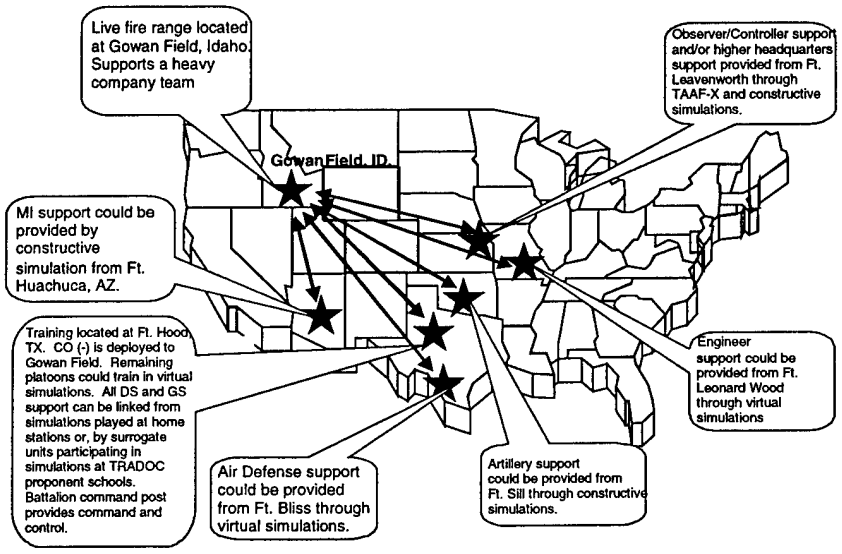


Figure 7. Linked training for a company team live fire exercise.

Execution

The battalion task force commander and CP participate via a simulation at Ft. Hood. (Other elements of the task force could participate in simulations linked to the attack conducted live at Gowan Field.)

In the live fire event depicted in Figure 8, the company team mission is to assault an enemy position. The company team attacks with one mechanized infantry platoon and one tank platoon on the ground at Gowan Field and with one tank platoon in a virtual simulation at Ft. Hood or at Gowan Field. (Having

both tank platoons at Gowan Field would provide the commander the opportunity to rotate the platoons into the live fire environment while maximizing the training opportunity for each element.)

In our example, air defense and Military Intelligence support are provided by a surrogate element. All other habitually associated components of the company team are available at Gowan Field. One field artillery platoon deployed to Gowan Field and is supporting with live artillery fires. The remainder of the field artillery unit participates in the training through simulation from home station. An engineer platoon is on the ground to provide obstacle-breaching support during the live fire exercise while the remainder of the engineer company also supports through simulation from Ft Hood. The company team commander will be on the ground in his fighting vehicle to monitor the situation and to direct the company-team attack using all his elements. He will also be able to personally observe and assess the proficiency of the units on the ground.

Such an event conducted on this notional range provides the commander the capability to conduct an assault on a traditional terrain feature or a built-up area depending on his training objective. With two or more platoons available to train with live fire, he could increase the complexity of the live fire assault. With adaptable and movable target arrays, the live fire elements should not see the same threat in the same locations, regardless of the number of iterations. The movement of friendly elements can also be replicated with three dimension replicas of soldiers and vehicles if the maneuver of actual personnel and vehicles would be unsafe.

The range can support the company-team's consolidation of its position. Targets could be arrayed to replicate an enemy counter attack on that position. The timing of the counter attack could be triggered automatically in accordance with the enemy's doctrine. Or, the exercise director of an externally supported event could dictate the time of the counter attack. He could also create battlefield "fog" and "friction" by varying the amount of information available to the commander or, by affecting the actions of units in the simulations.

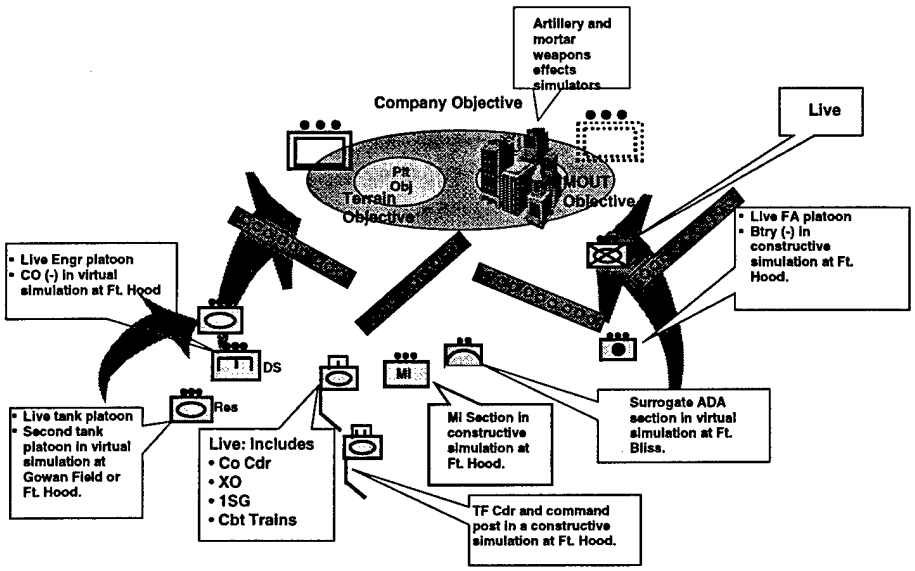


Figure 8. Company team live fire range and training scenario.

## Example B, Battalion Task Force Attack

### Task Organization

A heavy battalion task force task organization is provided at Figure 9. The task force is formed by organizing one mechanized infantry company with the two tank companies. Elements participating in this event include one pure tank company, two tank company teams, and the scout, mortar, and support platoons. Additionally, the battalion tactical operations center, combat trains elements, and field trains elements participate in the training. Other habitually associated units in the battalion task force include an engineer company, an air defense platoon, a military intelligence platoon, forward support company, and a chemical section. A field artillery battalion is in direct support.

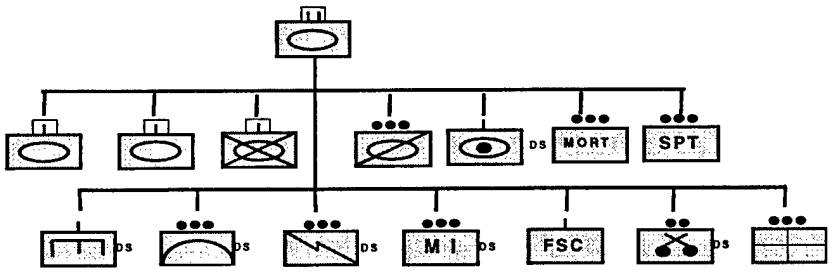


Figure 9. Battalion task force organization.

Training Concept

In the battalion task force scenario (Figure 10), the battalion/TF's parent brigade headquarters is also located at Ft. Hood, Texas. The majority of the battalion's organic elements are deployed to Ft. Irwin, CA for live fire training rotation at a time when the TF training event will not interfere with an ongoing NTC rotation by another unit. Those combat, CS and CSS units not able to deploy would participate in the task force training from Ft. Hood using either virtual or constructive simulations. Surrogates for those units not available at Ft. Hood would be furnished by the branch proponent schools via linked simulations in order to permit the TF commander and staff to monitor and direct the actions of a complete task force as was described in the company team example. Again, analytical support would be provided from Ft. Leavenworth through TAAF-X capabilities.

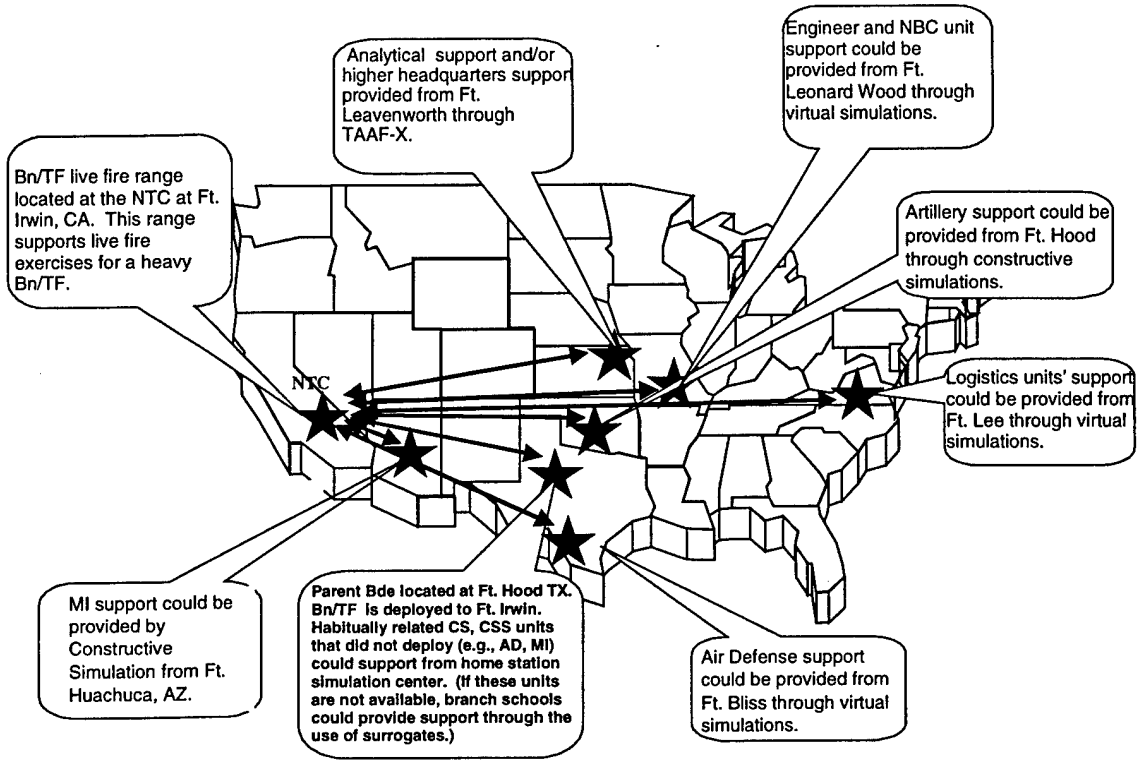


Figure 10. Linked training for a task force live fire exercise.

Execution

In this offensive live fire scenario (Figure 11), the battalion task force mission is to conduct a deliberate attack against a fortified enemy position. The battalion task force conducts training with one mechanized infantry company team and one tank company team on the ground at Ft. Irwin, while the other tank company participates in the training through a virtual simulation at Ft. Irwin. The mortar platoon supports on the ground with live fire. (Having all organic elements at Ft. Irwin provides the commander the opportunity to rotate companies and separate platoons into the live fire or simulations environment, thereby maximizing the training opportunity for each element.) A field artillery battery also deployed to support with live artillery fires. The remainder of the field artillery battalion participates in the training through simulation from home station. An engineer company provides obstacle-breaching support during the live fire exercise. Coordination was made to provide live Tactical Air and Army aviation support during the exercise. A MI Platoon from the MI battalion normally associated with the battalion task force participated via a simulation at Ft. Hood. A surrogate Air Defense platoon participated from Ft. Huachuca. The battalion commander is on the ground in his fighting vehicle providing

leadership well forward as well as monitoring the training of his task forces.

The brigade combat team commander and CP participate via a simulation at Ft. Hood. (Other elements of the brigade combat team could participate in simulations linked to the attack conducted live at Ft. Irwin.

This range provides the commander the capability to conduct an assault on a traditional terrain feature or a built-up area or both. With two or more companies in live training, he could assault with both. With adaptable and movable target arrays, the live fire elements will not see the same threat in the same locations, regardless of the number of iterations. This live fire range would have the capability to allow a battalion to consolidate and then defend against a counter-attack.

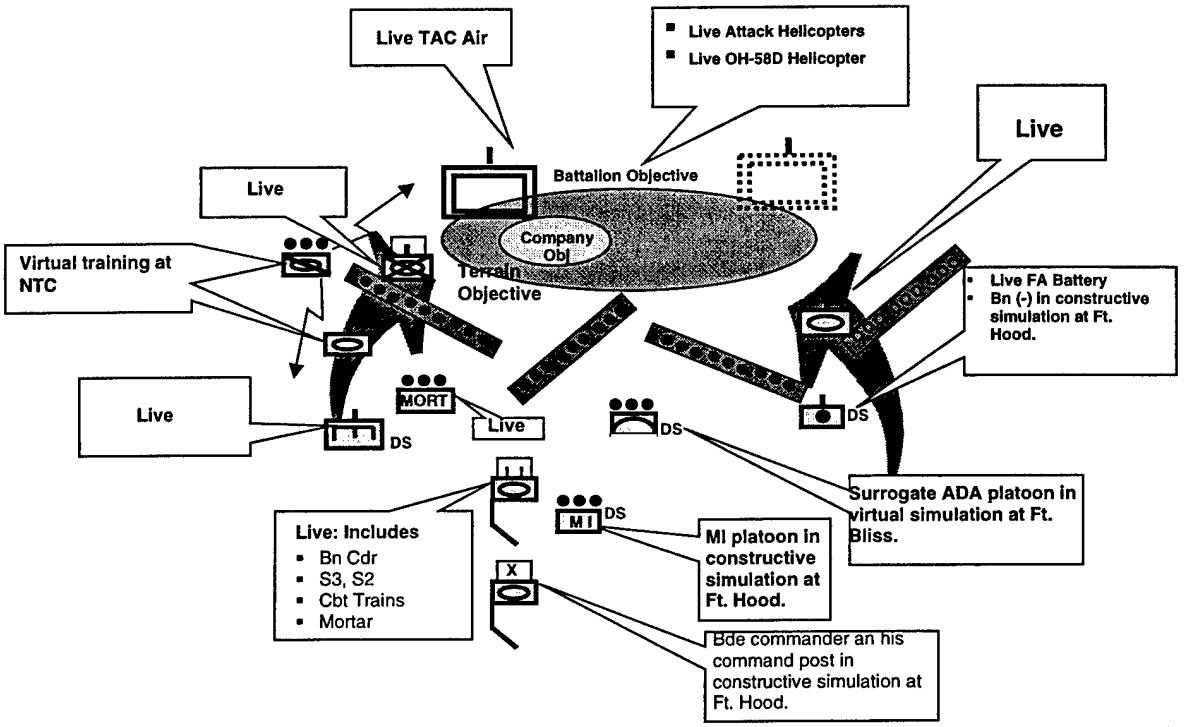


Figure 11. Battalion task force live fire range and training scenario.

Such a range area complex established at Ft. Irwin would also be available for use by units as part of their rotation to the NTC. The rotational battalion task force would attack or defend under more realistic conditions. At the same time, the BCT commander could monitor, plan, and direct the actions of his three battalion task forces and all the BCT's other combat,

support, and combat service support units through the use of simulations linked to the live fire "box". Units not in the live portion of the event would participate in simulations conducted at Ft. Irwin or their home stations. Units not available would be replaced by surrogates playing at TRADOC Proponent Schools' simulation centers. Such a combination of simulations linked to the live fire "box" would expand the present NTC training event wherein brigade combat team commanders conduct a brigade attack with one battalion in live fire and another in force-on-force.

## Impact of the Interim Brigade Combat Team Initiative on Future Live Fire Training Requirements

During the conduct of this study, General Eric Shinseki, the Army Chief of staff, announced plans to create brigades that could respond to conflicts anywhere in the world within 96 hours. Two Fort Lewis brigades were chosen to be the first units reconfigured and trained for this capability.

The Interim Brigade Combat Team represents a sharp departure from existing organizational concepts within the Army. It is non-traditional with respect to design, deployment process, and manner of employment. We can also assume that it will be non-traditional in its training requirements. Training for the new brigades will have to support the qualities of high mobility (strategic, operational and tactical) and an ability to achieve decisive action through dismounted infantry assault. The Army Live Fire Training Strategy and notional range concept proposed in this study are suited to support the training requirements of the Interim Brigade Combat Team.

These new brigade combat teams will require a live fire training capability that replicates employment as an early entry combat force performing conventional offense and defense, MOUT, and SASO missions. Training areas will be required to support a multi-dimensional battlespace. The brigade must be afforded the capability to train to dominate the electromagnetic spectrum to assure uninterrupted information flow and to degrade/deny that same data flow to its adversaries. Because of the variety of missions that it may receive, it must have access to realistic force-on-force and live fire training in facilities that can be adapted to a variety of METT-TC conditions. All training support must enhance the brigade's capability to operate effectively in both conventional and asymmetrical environments.

# Conclusions and Recommendations

## Conclusions

This study and the initiation of actions to future training requirements could not be more timely. During the conduct of this study, the Army announced its vision for a force to meet the requirements of the 21st century. The Army is undertaking immediate actions to transform itself into a strategically responsive force capable of dominating actions across the full spectrum of operations. A force is being assembled that will be quickly deployable, agile, versatile, lethal, survivable, and sustainable. Within the context of this doctrinal and organizational change, we offer the following conclusions:

- The Army needs a training strategy that addresses live fire training for the entire Army. Functional activities, CS units, and CSS units should be included.

- Current TADSS and current live fire ranges will not meet the cumulative effect of force modernization and demands of the asymmetric battlefield.

- Live fire training of collective tasks should be more realistic in terms of the sights and sounds of the battlefield. Increased STRAC allocations of pyrotechnics, smoke, and explosion simulators are required.

- Home station facilities for training collective tasks with live fire should be reconfigured frequently enough so that they always provide an appropriate challenge to leaders and soldiers.

- Achieving and sustaining flexibility and lethality will require units to train extensively under simulated conditions that are close replications of how they will fight. Live fire training is certainly part of the way units can meet those requirements.

- Present MOUT live fire training facilities do not replicate the conditions of fighting in large cities.

## Recommendations

- ADST propose the live fire training strategy to TRADOC DCS-T for adoption as part of the Army's training strategy.

- TES be enhanced to replicate a reasonable array of worldwide threat weapon systems and that there TES be distributed to support all live fire training.

- The Army develop simulators for a variety of threat capabilities and issue them to home station training facilities.

- The Army provide home station training facilities with the means to easily vary target arrays to challenge training opportunities and prevent scenario replication.

- STRAC allocations of pyrotechnics, smoke, and explosion simulators be increased to enable more realistic live fire training.

- The Army appraise the notional live fire range concept with its combination of improved targeting and weapons effects, capability to use all C4ISR equipment, and leveraging of live, virtual, and constructive simulation in terms of its feasibility to support collective live fire training at battalion task force level and below.

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# APPENDIX A

## ACRONYMS AND ABBREVIATIONS

ARI .....Army Research Institute
ASAS .....All Source Analysis System
ATCCS .....Army Tactical Command and Control System
ATMD .....Army Training Modernization Directorate
BCT .....Brigade Combat Team
BOS .....Battlefield Operating System
C4I..... ...Command, Control, Communciations, Computers, and Intelligence
C4ISR .....Command, Control, Communciations, Computers, Intelligence, Surveillance, and Reconnaissance
CMTC .....Combat Maneuver Training Center
COG .....Commander, Operations Group
CP .....Command Post
CS .....Combat Support
CSS .....Combat Service Support
CTC .....Combat Training Center
EW .....Electronic Warfare
FA .....Field Artillery
FAADC2 .....Forward Area Air Defense Command and Control
FARRP .....Forward Area Rearming and Refueling Point
FBCB2 .....Force Battle Command Brigade and Battalion
FM .....Field Manual
FTX .....Field Training Exercise
GAO .....General Accounting Office
IAW .....In Accordance With
JRTC .....Joint Readiness Training Center
LFE .....Live Fire Exercise
LFF .....Live Fire Futures
LOSAT .....Line-Of-Sight Anti-Tank
MCS .....Maneuver Control System
MDMP .....Military Decision Making Process
METL .....Mission Essential Task List
METT-TC .....Mission, Enemy, Time, Terrain, Troops and Civilians
MILES .....Multiple Integrated Laser Engagement System
MOUT .....Military Operations on Urban Terrain
MTP .....Mission Training Plan
NTC .....National Training Center
O/C .....Observer/Controller
OPFOR .....Opposing Forces
SASO .....Stability And Support Operations
STOW ..... Synthetic Theater of War

TAAF-X .....Training Analysis And Feedback-Center of Excellence
TADSS .....Training Aids, Devices, Simulators, and Simulations
TF .....Task Force
TRADOC .....Training and Doctrine Command
TT .....Tank Table
UMCP .....Unit Maintenance Collection Point
USAREUR .....United States Army Europe